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DURATION AND THE TEMPORAL JUDGMENT¹

By JOSEPHINE NASH CURTIS

INTRODUCTION

The tendency of modern text-books of psychology has been to abandon the concept of duration as a derived character of mental processes or as a relation of psychical elements, and to adopt in its place the view that duration is an attribute of sensation co-ordinate with quality and intensity. The basis for this change has been in the main logical and theoretical; but the question must arise whether we can obtain any introspective evidence for the ultimate character of duration. There are, of course, two possible sources of such evidence: incidental references to the matter in the experimental literature, particularly that of the 'time-sense'; and introspective data obtained by further investigation which has, as the older experiments had not, the question of the ultimate character of duration as its goal.

Study of the literature of the subject proved less fruitful than might at first be imagined.² The first of the experimental studies to discuss the nature of duration is that of Mach,³ who says that all sensations

¹ From the Psychological Laboratory of Cornell University.

² The writer read, beside the references given in E. B. Titchener, *Experimental Psychology*, vol. II, part ii, 1905, 394-400, the more recent work such as that of Benussi, Yerkes and Urban, Urban, Overstreet, Rageot, Burrow, Lobsien, Peres, Schmied-Kowarsik, Brewer, Gildmeister, Stratton, Wallin, Biehle, Dunlap, Pitkin, and others listed in the current bibliographies, beside many articles which proved to be concerned with the philosophical, musical, or physiological, rather than with the psychological aspect of our problem.

³ E. Mach, *Wiener Sitzungsber.*, math.-naturw. Cl., 51, Abth. 2, 1865, 133; *Die Analyse der Empfindungen*, 1902, 185ff.

are accompanied by the time-sense. He attempts to reduce this 'time-sense' to attention, and places himself on the side of those who believe the temporal element is not an ultimate datum. In his later writings,⁴ Mach upholds a definitely genetic theory of time, and so denies that duration may be an attribute of sensation. Vierordt⁵ remarks that "the operations whereby we gradually come to a concept of the temporal and the spatial, and which allow us, even compel us, to add to our sensations the measure of time and space are completely hidden from us," and that "the spatial and temporal dimensions of sensory stimuli come, so to speak, immediately into our consciousness." Fechner⁶ maintains that "a longer time between two impressions appears longer not on account of its abstract, empty, physical size, but on account of the greater sum of psychophysical activity which it includes," thus indicating that duration is to be considered neither as mere physical duration, nor as an immediately given character of mental process.

Münsterberg,⁷ after many experiments performed upon himself, concludes that our time sense is manifested in a hundred forms, but that all these forms have strain sensation as basis. For short intervals he finds rhythmic tensions of the muscles about the sense organs the basis of judgment. For all intervals, however, the processes accompanying respiration primarily determine our estimation of time. Nichols⁸ concludes that duration is an attribute of every sensation and every image, and that this attribute is the ultimate and essential datum of time although his conclusion seems little connected with his experimental work. He distinguishes between perception and apperception of time.⁹ Time, for him, is apperceived "when any process of duration occupies the focus of attention, is the object of association, and calls up durative associations," and it is only as associated ideas of length that we have the muscular tensions, dermal stretchings, joint pullings, etc., that have been taken by others to be the sole components of the perception of time. Münsterberg and Wylie¹⁰ confirm Münsterberg's earlier work by finding that the "subjective measure for time lengths seems to lie in sensations peripherally aroused by muscular activity, especially by the strains and relaxations which take place in the various groups of muscles conditioned upon bodily reactions to changing intensities of stimuli. Such reactions occur in the functions of breathing, in the voluntary movements of the eyes, limbs, etc. Stevens¹¹ also denies the immediacy of temporal judgments. He writes "our judgment of time is mediate, depending upon organic processes, of which change in blood volume is one of the more important." Aliotta¹² names rhythm and expectation as two criteria in judging times, and says that the former is more effective for short times, the latter for long, but he

⁴ *Erkenntnis und Irrtum, Skizzen zur Psychologie der Forschung*, 1906, 423ff.

⁵ K. Vierordt, *Der Zeitsinn nach Versuchen*, 1868, 13f.

⁶ G. T. Fechner, *Abh. d. kgl. sächs. Ges. d. Wiss., Math.-phy. Cl.*, 13, 1884, 7.

⁷ H. Münsterberg, *Beiträge zur experimentellen Psychologie*, II, 1889, 20.

⁸ H. Nichols, *Am. Jour. of Psych.*, 4, 1891, 85.

⁹ *Op. cit.*, 92ff.

¹⁰ H. Münsterberg and A. R. T. Wylie, *Psych. Rev.*, 1, 1894, 52.

¹¹ H. C. Stevens, *Am. Journ. of Psych.*, 13, 1902, 26.

¹² Aliotta, R., *Istituto di Stud. sup. di Firenze, Ricerche di Psicologia*, 1, 1905, 1ff.

does not go into detail. Up to this point the writers, with the exception of Vierordt and Nichols, have insisted on the secondary character of temporal judgments. Meumann¹³ now carries out a long series of experiments, the result of which attests the immediate character of these judgments, and apparently the ultimate character of duration. He works under Wundt's direction, and the system in terms of which he naturally expresses his ideas makes duration a creation of the synthesis of sensation with feelings of expectation and fulfillment. Nevertheless he writes: "According to my notion *every* psychical process is measure of time in the sense that every psychical process brings to consciousness, through its qualitative and intensive *changes*, temporal relations of *succession*; and through its relatively *unchanged persistence* in respect to quality and intensity, temporal relations of *duration*. . . . Whether or not all psychical processes can bring temporal relations to consciousness in an equally *accurate*, and—for our apprehension—an equally *convenient* way, or whether we perhaps *favor* . . . certain psychical processes to make the temporal relations clear, just as we depend on the eye for the estimation of space, although we could use the hand or arm, is quite another question."¹⁴ He goes on to say: "I presuppose as a final fact of experience, incapable of further discussion, that the processes of our consciousness, of our inner perception, are given constantly at the same time as processes of a *temporal* nature, i. e., as standing in a temporal relation, and that we can bring these temporal relations of our conscious processes to consciousness in relative abstraction, just as we can perceive relations of intensity in comparative isolation, although they are always there merely as the intensive steps of certain qualities. I shall further take it for granted that this temporal state, which is brought to consciousness in relative isolation, can be made the unique object of a judgment."¹⁵ He then distinguishes between mediate and immediate judgments of time, and urges that both kinds occur. From the observations of his subjects, as well as from his own more or less theoretical conclusions, he argues for the immediacy of temporal judgments. "Since it is so difficult to compare two differently filled times, the observers easily hit upon artificial aids to judgment, thinking thereby to make the judgment easier. This course, however, I always prohibited, and requested a *purely passive resignation to the impression of the interval of time*. It is interesting to note that in the course of the experiment all such aids as beating time, nodding the head, respiratory movements, innervation of the larynx, rhythmical counting, and so on very soon disappeared. They were recognized by the observers as disturbances, rather than as aids." Meumann, then, states definitely his belief in the immediate nature of the judgment of time, and he seems to imply also that duration is an ultimate datum of time. He speaks, to be sure, of 'temporal relations,' but quite as he might speak, if he liked, of 'intensive relations' rather than of intensity. His comparison of 'temporal relations' with intensity, and his approval of Nichols' statement that duration is an irreducible attribute of sensation (when Meumann quotes Nichols (*ibid.*, 8, 1892, 503) he speaks of the "elementary, irreducible time experience," though Nichols himself says "attribute of every sensation and every image") seem to place Meumann in the group of those believing in the ultimate nature of duration.

¹³ E. Meumann, *Phil. Stud.*, 8, 1892, 450ff.

¹⁴ *Op. cit.*, 504.

¹⁵ *Phil. Stud.*, 12, 1896, 143.

Now, again, denial of the final nature of duration appears. Schumann¹⁶ says: "A secondary impression of suspense of expectation is noticed before every impression, though I can not determine on the basis of introspection whether it consists of strain sensations aroused by muscular contractions, or of internally aroused feeling of strain. The secondary impressions of expectation and surprise are really the psychic contents on which we rely in comparing short times." Elsewhere,¹⁷ however, he acknowledges that there may be another psychical element present in time-comparison which has escaped notice, and finally¹⁸ he concludes that although accurate and subjectively certain judgments are always mediate, the question of whether we can ever judge two intervals immediately "is not wholly simple to decide." Quandt¹⁹ is not definite as to the true nature of the judgment, but asserts that "estimation by secondary peripheral accompaniments on which Münsterberg has sought in greater part to base his theory of time-perception may on no account be considered conclusive." Katz'²⁰ observers find that in general certain strain sensations seem to be essential to the experience of time. Katz finds judgments like those of Schumann in which the observer expects the second member to equal the first and judges whether this member stops too soon, at the proper time, or too late to equal the first, and he also finds judgments of absolute impression. Further discussions of these forms of judgment and of Katz' criticism of Meumann's passive instructions will be given later in this paper. Alvord and Searle²¹ found that in general judgments are made on the basis of strain and relaxation, imagined movements, auditory rhythm and the spontaneous occurrence of auditory images of the stimulus, although some intervals were said by one observer to be judged 'mechanically.' Schultze²² speaks of the spatial, intensive, and qualitative characters of "experience and mental structures" and concludes that temporal extent is a fourth such character which cannot be reduced to the others. Moede²³ instructs his observers to give "free" judgments. From their reports he finds two basic constituents (*Grundbestandteile*)²⁴ of every temporal consciousness: duration and progression (Fliesen). "At one time the observer may give himself up to temporal course and is then taken up with the progression of the quality. At another time he may lift himself out of the level of the continuum and look out from a higher, as it were resting, point of view. In the one case he is like the boat in the stream, which is carried on by the waves, whereas in the other he is like the viaduct through which the stream of temporal quality runs. The natural set is a mixture of the extremes, which can best be described as *progressing duration*."

Let us now see what arguments are urged as showing that duration cannot be an original character of sensation. There

¹⁶ F. Schumann, *Zeits. f. Psychol.*, 4, 1892, 2.

¹⁷ *Ibid.*, 17, 1898, 113.

¹⁸ *Ibid.*, 125.

¹⁹ J. Quandt, *Psych. Stud.*, 1, 1906, 153.

²⁰ D. Katz, *Zeits. f. Psychol.*, 42, 1906, 302ff.

²¹ E. A. Alvord and H. E. Searle, *Am. Journ. of Psych.*, 18, 1907, 177.

²² F. E. O. Schultze, *Arch. f. d. ges. Psych.*, 13, 1908, 275.

²³ W. Moede, *Psych. Stud.*, 8, 1912-13, 327.

²⁴ *Ibid.*, 366.

are two main arguments against the attributive character of duration. The first is the argument of the Wundtian school, —the argument from relativity. Statements of duration, it is said, can only be relative. Any temporal experience whatever implies logically a relation to other experiences; to be durative at all, experience must be apprehended as longer than, shorter than, or equal to another, before or after or simultaneous with another; and an experience which merely lasts, but does not last for a definite time, or at a definite time, is unthinkable. Psychologically, this objection takes the form of stating that duration is a perception, the character of which has developed from the interplay upon sensation of other processes, such as strain sensations or the various feelings which are connected with the sensation in experience. Duration, accordingly, must be regarded not as an original character, an attribute of sensation, but as the final product of a creative synthesis. Such an objection can hardly be met by direct introspection, by observation pure and simple. But if we find cases in which there appears an approximation to a duration which introspectively is neither longer, shorter, nor equal with regard to another, we shall go some way toward meeting the logical argument.

The second argument against the attributive character of duration makes a more direct appeal to introspection.²⁵ "Suppose, then, that we allow sensations a psychic duration, as distinguished from objective duration. Whatever the character of this consciousness, it must be contained in the 'psychic present,' else surely we are no longer dealing with a single element. Within this limit, then, sensations must be capable of differing in subjective duration. But can the 'psychic present' have subjective duration? . . . The psychic moments follow each other; they have no duration. The perception of duration is the perception of two or three such successive moments having similar contents. . . . While it seems absurd to treat their objective duration as one of the attributes of sensations, yet the only other way to maintain that they have a temporal attribute is to hold that the subjective present does possess subjective duration, a view which I think introspection does not confirm." The proving or disproving of the attributive character of duration, then, according to this view, lies in the introspective question whether a sensation may be perceived as duration within the limits of the conscious present.

From the results of our experimental work we shall en-

²⁵ M. F. Washburn, *Psych. Rev.*, 10, 1903, 421ff.

deavor to draw two main conclusions. First, that the results of previous investigations are not as contradictory as they at first seem; secondly, that the two chief arguments against the ultimate nature of duration are not supported by experimental observation.

Experimental Investigation

Purpose: As already stated, the main object of this series of experiments was to discover what evidence introspective analysis offers for the attributive nature of duration.

Stimuli: Following the example of many earlier investigators, we used auditory stimuli throughout the first groups of experiments.

Apparatus: The length of the stimuli was controlled by a device attached to the Leipsic 'time sense' apparatus.²⁶

This device consisted of four aluminum arms clamped to the central shaft of the rotating disc, and so arranged that, when two of the Leipsic lever-contacts were in position, the first arm moved the one lever of the first contact the second arm the other lever. The third and fourth arms acted similarly upon the second contact. In order that a given pair of arms should not act upon both contacts, it was necessary merely to raise one contact slightly and to raise the corresponding arms. By this arrangement the first two arms moved the first contact and passed under the second; the other pair moved the second contact similarly, but passed over the first without touching. In order to prevent the single member of a pair of arms from moving both levers of a contact, a small copper post was erected upon one lever of each contact, a short distance from the point of the lever, and the corresponding arm raised slightly and given an appropriate length. With such arrangements, when the Baltzar kymograph, to which the whole apparatus was attached, revolved, the disc of the time apparatus revolved also and each arm moved only one lever of one contact. Further advantage of the aluminum arms lay in the fact that they were so attached to the shaft that either the first arm or the fourth arm might be shifted in position without altering the positions of the other three. It was thus possible to vary the length of the first, of the second, or of both members of any pair of stimuli. The sound itself was given by an electrically driven 254 v. d. tuning fork. The fork was placed in a sound-proof box with its resonator opposite a telephone transmitter. The transmitter and a dry-cell were connected with the primary coil of an inductorium; the contacts of our apparatus and two telephone receivers, one for experimenter and one for observer, were connected with the secondary coil. A switch was introduced in such a way that the experimenter could hear the sound in the receiver whenever the kymograph revolved, while the observer heard the sounds only when the switch was closed. The tone which the observer heard was of moderate intensity, and was without unpleasant buzzing of the receiver. At first the kymograph was tested

²⁶ A diagram and detailed description of the 'time sense' apparatus may be found in W. Wundt, *Physiologische Psychologie*, 2, 1893, 424, and in Meumann, *Phil. Stud.*, 9, 1894, 270.

every two or three weeks; but after a number of trials it was found that the average deviation for ten readings was never more than .02 sec.; so that in the later work the apparatus was tested only at the beginning of a new group of experiments. A series of readings taken to find with how great accuracy the experimenter usually set the instrument showed a mean deviation of .03 sec. The observer was placed in a quiet dark room and heard the sounds through a telephone receiver attached to his left ear. This dark room and the room of the experimenter were connected by a system of electric bells, which enabled warning signals and reports of judgment to be sent from the one room to the other, as well as by a speaking tube through which the observer gave his introspections.

Method: The psychophysical method used in all the experiments was that of constant stimuli. The series were from 12 to 16 members in length, and in all except the first group (in which irregular steps were used) the steps were of .1 sec.

General procedure: The experimenter started the kymograph, allowed it to rotate twice to attain its maximal speed, rang two warning bells²⁷ 4 sec. and 2 sec., respectively, before the first sound was to be heard, closed the switch, and opened it again after the second sound had been given. The kymograph was then stopped, the judgment which the observer had rung on his bell was recorded, a new setting was made, and the procedure was repeated. The time from the ringing of a judgment to the first warning bell for the next pair of stimuli was approximately 45 sec.

Treatment of results: Our chief interest lay in the introspections, and no claim is made for the significance of the numerical results. There are in general entirely too few cases in any group to have any importance, and no attempt has been made to make the quantitative series complete, i. e., to compensate for time-error, etc. All the limens have been calculated by the method of right and wrong cases. In the mathematical work, Urban's table and Crelle's three-place multiplication tables were used. All our results are recorded in the number of degrees on the instrument ($50^{\circ}=1$ sec.).

Group 1

This group consists of preliminary experiments, whose general purpose was to find what secondary criteria were most likely to come into the judgment of time-intervals even when the observers were warned against such criteria, and to obtain hints for the direction of further work. Two continuous sounds were given with an interval between them of 1.5 sec. Three standard times were used: 50° , 75° and 100° , given in both time orders.²⁸

²⁷ Observers Bo and D, and later Gou and W preferred one warning bell and there seemed no reason for insisting on two being given.

²⁸ Only one contact was used on the apparatus.

Observers: Dr. E. G. Boring (Bo), instructor in psychology, observed 7 hours; Mr. F. L. Dimmick (D), graduate student, 15 hours; Dr. W. S. Foster (F), instructor in psychology, 20 hours; and Dr. M. E. Goudge (Gou), graduate student, 30 hours. Bo, F, and Gou were highly practised observers; D was relatively inexperienced.

Instructions to observers: "About two seconds after the second warning signal you will hear two sounds in the telephone receiver. You are to judge whether the second of these is longer than, equal to, or shorter than the first. Give your judgment with the push-button as follows: shorter than, 1 ring; equal to, 2 rings; greater than, 3 rings. If it should be necessary to give a doubtful judgment, give two short rings after the rings for the judgment. You are warned to be on the lookout for secondary criteria, and especially not to get in the habit of judging by some secondary criterion."

Results: The quantitative results of this group are so scanty as to be wholly without significance.

From the introspections²⁹ we find, as Meumann did, that at first all sorts of 'artificial' aids are employed in making the judgment.

The most commonly used aid is *kinaesthesia* in some of its manifold forms. Bo reports at first that "chest kinaesthesia has a great deal to do with it. I get a very definite muscular feeling as if I were pressing down inside my chest. It is quite independent of breathing; is probably imaginary. These processes carry the course of the sound; by that I mean that during the sounding of the second member, I assume the attitude of making the noise voluntarily myself, i. e., I screw this chest pressure down as if it were making the noise." At a later date Bo says: "There always seems to be relevant kinaesthesia in the body somewhere."

At first D, also, reports kinaesthesia: "Carried the first over sort of kinaesthetically," "sort of hummed along with both tones, then decided whether the second felt longer, shorter, or equal," and "judgment passed according to the kinaesthesia."

Gou used in general eye-kinaesthesia. She reports: "images representing the length of the two members, consisting for the most part of kinaesthetic sensations in the eyes, meaning 'length of tone as represented by a line which I couldn't see, but which I localised.'"

Early in the experiments F stated that "the sound comes, is attended to clearly, the head goes forward slowly just a bit, keeps moving forward all the time the sound is there, at the end it comes back with a sudden jerk. With the second sound, the head goes forward again just the same sort of way and snaps back at the end," and "when the second sound had gone on as long as the first, which I think also means, when the head movement had gone on as long and as far as

²⁹ The excerpts from the introspections which are quoted are, of course, very scanty, but they are representative. The complete introspections are left in the Cornell psychological laboratory.

the first head-movement. . . ." After some practice, F reports that the body and head kinaesthesia disappeared.

When warned that the use of kinaesthesia might be interpreted as constant reliance on particular secondary criteria, D³⁰ reports that the kinaesthesia is not necessary for the judgment: "don't think there was any kinaesthesia here, though the judgment seemed just as easy to make."

Special instructions were given to Gou to do away with kinaesthesia entirely, but this proved to be impossible. She says: "I can't just have tone sensation and nothing else in consciousness unless I give myself up passively, and then I am not judging anything."

Bo observed for so short a time that it is impossible to say whether with further practice he would have discarded kinaesthesia, or whether he would have been able to do so under instruction.

All observers report at times supplementary "representations," or "formulations," of the sounds. In general these are most frequent in the first stages of the experiments, and when there is some doubt about the judgment. They usually appear either between the members or after the second member. They are found in various sense-departments, may arise involuntarily or be called up voluntarily, and may be either detailed or abbreviated.

Bo says: "I formulated the length of the first member just about at its end. By formulation I mean that there seems to be some way in which the length of the member gets itself represented. I don't think this representation is a temporal course; if it is, it is a very much abbreviated one. I can't describe the thing which carries the length of that member, but I think it is like kinaesthesia"; "the formulation involved auditory imagery"; "the formulation is the whole sound in a nut-shell (running off in perhaps 1/50 of the time of the member), temporal course and all; some chest kinaesthesia, some ear kinaesthesia, and some auditory image." Bo also speaks of "visualising the members as running along together."

D speaks of "visualising the two sounds as a couple of gray streaks," "carrying the first sound over kinaesthetically," and one day, "visual images seem to mean the sound, but I don't think I judged the lengths of the sound by them."

F reports various kinds of representations: "went over the whole thing in imagery (visual to a great extent) in some short-hand way"; "the going over in imagery has much more kinaesthesia in the throat than much of my ordinary imagery of sounds"; "went over the whole experiment in image, mostly auditory, which I don't think took as long as the actual experiment"; "intentionally ideated the thing schematically, both auditorily and visually"; "there was a representation which, as nearly as I can tell, was an auditory image of the end of the tone over again with some realization that there was more ahead of it and how much more there was ahead of it. What that realization was I simply don't know;" and "this time it was a real representation, sometimes it is symbolic."

Gou speaks of a "fixing" of the duration of the first member in the interval, "by means of kinaesthetic terms; i. e., kinaesthetic sensations in the eye-region and trunk of the same kind as had accompanied

³⁰ D's later introspections, however, lay such stress upon the kinaesthetic and organic accompaniments of the comparison, that it seems possible that in these early experiments, before he attained practice in introspection, he may have overlooked vague or weak strains, etc., which he noticed later.

the first member were present and meant 'first member was just so long'; "very vague visual images representing the length of the two members"; "sometimes I choose between comparing quickly in schematic form and, as it were, living the experience over again"; "some kind of a representation of the member in scrappy and schematic form, in a nut-shell, one might say."³¹

In the method of forming the judgment we find several tendencies which agree more or less with the findings of earlier investigators. The most common tendency is expressed sometimes as "expecting the second to be just like the first" and sometimes as "laying the first off on the second."

Bo says: "It was almost as if the second itself meant the first, as if there were identity"; "I reformulated the first upon the second as a background. . . . I held the formulation as a sort of a static kinaesthetic thing with kinaesthetic kinks in it on the background of the smooth second tone. Then I cut loose from the formulation and anticipated the end of the second member. This anticipation was a sort of heightening of the kinaesthetic complex in which one kink became especially intense and in which reference forward was visual image or eye-movement (I don't know which). It was as if out of the complex I got a cue relevant to the end, as if I were set ready to 'go off'; the muscular feeling of an incipient action. The tone ran on, and just as it stopped the kinaesthesia changed as if I had 'gone off.' Then a moment's hesitation, then retrospection, mostly visual, of the tone and the kinaesthesia snapping off together, and the judgment of equality." "Some time after the second member had started, I voluntarily recalled the first member and started it running along with the second. Was slightly surprised to find they fitted although they hadn't begun at the same time, because I thought the formulation had to run a course that ran along with the second member and couldn't be started late."

D speaks of "carrying the first member over to the second largely as a kinaesthetic image in my throat" "this time the sounds seemed very much alike, seemed like the same one over again."

F reports: "In some way I identified the second sound with the first;" "I attend to the second tone as if it were the first tone being repeated. In a certain sense I expect the second tone to be the same as the first. . . . This attending to the second the same way I attend to the first, this expecting the second to be the same as the first, this taking the second tone as a repetition of the first, means that the end of the second tone is somehow expected to come at a definite place ahead"; "the second is apprehended as a repetition of the first. There seems to be no conscious process to carry the meaning that it is a repetition, it merely is a repetition."

³¹ These reports of 'short-cut' images and sensations which adequately represented the time-intervals are in direct contradiction to Nichols, who writes (*op. cit.*, 90): "I think that every one who will observe his own mental processes when he seeks to measure or to realise the length of any duration sensation or its representation in memory will easily observe that he never fully perceives or remembers the length instantly or even approximately so; unless, of course, the duration is itself instantaneous or approximately so. On the other hand, I think anyone will easily convince himself that *fully* to perceive or to remember the length of its representation, these representations must stretch themselves out through an equal process and lapse of time as did their original occurrence."

Gou did not state definitely that she ever took the second as a repetition of the first or that she "laid off" the first on the second.

A second type of judgment that began to appear near the end of this group of experiments was that called variously "automatic," "immediate," or sometimes "unconscious."

Even during the short time for which Bo observed he reports once that the judgment was "almost automatic," and several times that the ringing of the judgment was "unusually automatic, as I didn't think definitely of giving three rings until I was actually hearing the second."

D reports a number of times: "I knew it was shorter the minute the sound stopped"; "that was almost automatic, as I was thinking about something else"; "the deciding seems to me to be unconscious"; "I just hear the sounds and make the judgments without knowing why or how."

F gives many of these judgments: "end of the sound and start back of the body came at the same time. Automatically pushed the button twice"; "judgment touched off automatically, don't get internal speech or anything like that, just press button"; "automatically reacted with three very quick and strong pressures and was surprised. Haven't any idea why I pressed the button three times. Judgment was entirely automatic. Nothing in consciousness so far as I can see that represents the judgment or the judging. The mere longer duration of the second tone, without any consciousness that it was longer, seemed to touch off the reaction."

Gou reports continually: "immediately when the tone had ceased the judgment 'equal' appeared"; "immediate judgment carried by kinaesthesia in the throat"; "immediately at the end of the perception of the second member came an attitude meaning 'shorter' and I then reacted." When special instructions were given to Gou to "institute a direct comparison and not rely on immediate judgments," in an attempt to discover whether under such instructions her method would be similar to that of the other observers, she seems merely to add to her former method by supplementing the immediate judgment by a representation of each member, which, in turn, is followed by what she calls a second "immediate" judgment.

Apart from the introspections dealing directly with the process of judgment, we find many other statements which in reality bear more directly on the question of the nature of duration than those which have been quoted. Particularly to be noted are those which deal with the two dimensions of time. Titchener³² has written: "To the author, it seems that psychological time is . . . a surface, a bidimensional manifold, and that its two dimensions are simultaneity and succession."

In the introspections of Bo, the following is found: "I should say that the thing has perhaps what one might call duration but no temporal course. It may be something like Titchener's transverse temporal dimension. I think that I should say it all came within a single conscious present"; "I want until further notice to use the words duration and durative to mean a sort of static, non-spatial extension. This is my notion of the other dimension in bidimensional time, and it is also my notion of the measure within a conscious present. It doesn't move along although it may get bigger"; "the first tone was unitary, by which I mean it was all within a single conscious present."

F says: "attention is on the sound as a whole; i. e., the sound is

³² E. B. Titchener, *A Text-book of Psychology*, 1910, 340.

all one thing; even though it has a course, the sound is nevertheless all there at once"; "in some sense or other the first sound did stay in consciousness all through the experiment. I can't say that it persists as a memory after-image, can't say definitely that it didn't repeat itself. It certainly did not become longer. (Just as a visual image may stay in consciousness with its qualitative and extensive attributes unchanged, so this sound, which is primarily a durative thing, stays without change in its durativeness?)" ; "all I hear while the first stimulus is going on is one thing; in spite of the fact that the tone goes on and changes, it still is there simultaneously in some sense"; "the whole member is usually in one conscious present."

Gou gives a similar notion of the second aspect of time when she says "there seemed to be a holding over of the accompaniments of the auditory sensations, which may have been a sort of echo of the tone, or sometimes, a prolonging of the tone; this prolongation does not mean that the duration of the previous tone is made any longer, but just that I have hold of it, as it were."

The 'longitudinal' dimension of time is most clearly stated by F who repeatedly says that the tone 'goes forward,' "has a course"; "I do not mean that the sound moves in space when I say it goes forward; I am quite sure also that my eyes do not move forward from my ear as the tone goes on. The going forward of it is, to express it in another way, an addition to the tone in a special way. It is only a little thing when it first comes and it keeps getting bigger, there gets more of it, an increase in the tone in a special way. I am not able to say in what way, save by saying that it gets longer in time. It is almost as if you added more quality of the same sort to it."

Other evidence for the progression of the tones is found in the statement that the members sometimes fall into parts. Bo; "the members generally split up into two or three or possibly more parts." D; "I sort of divided the first member up," "the tone seemed pulsy;" F; "sound seems to change in quality or intensity as it goes on"; "sound seems to go forward with certain qualitative changes upon it"; "sometimes there are two or three of these changes in the tone."

The fact that three of our observers report that the members did not remain the same in intensity or quality throughout their length, and that they nevertheless report the sound as being "all there at once" and as "having duration," suggests Meumann's distinction between succession and duration (as already quoted, p. 3) and Moede's distinction (p. 4) between duration and progression.

There seems to be agreement among the observers that the consciousness of time may be taken in either of two ways. These two ways are designated by the majority of the observers as "dimensions." One and the same experience may be taken either as a moving duration, progression, or as a static duration which we shall call "length." The word "progression" seems better suited to the non-static view than does the more commonly used term "succession," because the latter name seems to imply too definite an interruption in the experience

Summary: In these introspections we find a confirmation

of Katz' statement³³ that the "observers at first found that slight movements helped the judgment, but that soon these voluntary movements dropped out." We find the chest strains of Münsterberg, the expectation and surprise of Schumann, and in the "automatic" judgments we seem to have the "mechanical" judgments of Alvard and Searle. There is also a tendency toward "immediate" judgments, although there is little evidence that they are based merely on the duration of the tone. Of all the ways in which the tones may be imaged or represented, kinaesthesia is by far the most important for all observers, and in the case of one observer at least, Gou, kinaesthesia could not be eliminated. As we have already suggested, the reports contradict Nichols' findings in regard to the temporal length of representations of duration. We find, moreover, distinctions drawn between the two dimensions of psychological time, and introspections which are contrary to the statement that the subjective present does not possess subjective duration.³⁴

Group 2

This group of experiments consists of a number of quantitative and introspective series in which a continuous sound (that given in Group 1) was to be compared with an "empty" interval marked off by two clicks.³⁵ The continuous sound, or the "filled" member, was always given first. In order that the results might be more or less comparable with those of Meumann, standard times of 60° (1.2 sec.) and 90° (1.8 sec.), with an interval of 2 sec. between members, were used. A slight change in instructions was introduced as the result of a procedure which most of the observers had adopted in Group 1. In regard to the doubtful judgments, the instructions now read: "If, at any time it is impossible to give anything but a doubtful judgment, ring in both possibilities, e. g., 'greater or equal.'" ³⁶

³³ *Op. cit.*, 321.

³⁴ Washburn, *loc cit.*

³⁵ As many investigators have already noted, there is no really "empty" interval when the time between two limiting stimuli is taken as stimulus; it is merely an interval whose *filling* is different from that of the "filled" intervals. In this paper, for the sake of convenience, the times between two limiting stimuli will be called "empty" intervals. By a simple shift of connections on the apparatus (see Wundt, *Physiol. Psych.*, III, 1911, p. 344) either member could be made to consist of continuous sound or of two clicks.

³⁶ In the mathematical calculations judgments of "greater or equal" are considered as "greater" judgments, those of "less or equal" as "less."

Observers: In addition to Bo, D, and F, who served in Group 1, two new observers were added. These were: Mr. H. G. Bishop (Bi), assistant in psychology, an experienced observer; and Dr. H. P. Weld (W), assistant professor in psychology, a highly trained observer. These 5 observers served throughout the remainder of the investigation.

TABLE 1
AUDITORY STIMULI
Filled—empty. Filled always the standard. Five cases each.

	S = 60°				S = 90°			
	Dl ₁	h	Dl _u	h	Dl ₁	h	Dl _u	h
Bi.....	-10.8°	.056	31.9°	.057	-5.6°	.033	23.8°	.037
Bo.....	-15.4	.518	36.5	.023	-6.9	.029	21.7	.025
D.....	-1.1	.033	22.6	.032	8.1	.051	12.0	.065
F.....	2.1	.025	16.5	.058	-9.5	.033	17.6	.028
W.....	-8.2	.034	20.5	.050	9.7	.017	8.8	.041

Table 1 exhibits the results of the series, the values of the Dl being expressed in degrees ($50^{\circ}=1$ sec.). The general conclusion from the quantitative results is that: *when a filled time is followed by an empty time, the empty time is usually underestimated.* This result agrees in general with the results of earlier investigators, but no detailed comparison can be made. As has been said already, we have so few cases that our numerical results are insignificant, and the differences between our stimuli and instructions and those used by others render any explicit comparison of the figures meaningless.

Introspective results: With a change of conditions, the comparing of an empty time with a filled instead of the comparing of two filled, we find, as we might expect, at first a constant use of all kinds of aid for the judgment. As was the case in the preceding group, these aids and secondary criteria tended to drop away after a time.

Bi uses all sorts of criteria. He says: "the two members were represented in visual terms after it was all over"; "after the clicks were over, both members were run through again. This consisted in kinaesthesia in the throat"; "the length of the tone seemed to be equal to, and to be measured by, the length of a vaguely defined thing which appeared to pass before the eyes"; "tone was represented visually and auditorily"; "the tone stood out as a luminous line all there at

once, while the clicks were represented by two dark points"; "duration of the tone was carried in eye-, ear-, and throat-kinaesthesia, with also certain modifications of breathing."

Bo at first relies on visual imagery, but later turns to a kinaesthetic laying-off of the first member on the second. "First member was visualised quite passively. After the second click the two didn't come up in imagery together as before, so I voluntarily imaged auditorily and visually the first click and the beginning of the tone, and ran the time through to see which would come out first. There were organics in this judgment. The end of this course was not definite. The breathing, I think, marked the end, but I didn't know of which member it was the end. Then I got the two together in visual imagery, the lengths representing duration, and compared them." When Bo was asked whether he could make the judgment without visualising the members, he replied, "being told to judge these without visualising, is like being told to add two numbers without thinking of them." Later, however, he found that he could use kinaesthesia to carry the first member over to the second, instead of calling up two visual images after the whole experience. "I should say that my attitude toward the second member, which made me judge it as shorter, was somehow conscious as the kinaesthetic hang-over from the first member"; "along with the second member I represented the first member by a course of shoulder kinaesthesia. The second click came as a surprise. The shoulder kinaesthesia was still in full swing and I should say my judgment formed immediately"; "I am quite sure, when I get the first member represented in kinaesthesia stopping before or after the second click, that I can make a judgment, although I don't always know what the judgment should be until I have a visual image."

D seems to use a method similar to this latter one of Bo's throughout the group of experiments. "I have a muscular and organic feel which seems to originate in accompaniment with the first member. Then when the second member starts, there is a repetition of this feel which is weaker, but so far as I can see is the same otherwise. The judgment depends on the effect the second member has on this feel; i. e., when they are the same there comes a comparatively gradual relaxation from this muscular tension and organic excitement. The feel, of course, has a temporal course dependent on the length of time of the first member, it runs the same temporal course with the second member that it did with the first. When the second member stops too soon or runs beyond the temporal course of the feel, there is a change in the feel which means to me a difference in the length of time." The feel, he says, he has "characterised before as expectation of the second member." D also reports "a visual pattern of the members in three dimensions," which continues the same almost all through the series of experiments.

F considered his results physically more exact when he laid one off on the other, by means of a voluntarily recalled auditory image of the first member; "the click and an auditory image which goes through the same changes that the first member went through, together make up or *mean* a repetition of the first. I always go on with the second member as if I expected it to be equal to the first;" "there is no second member for me. The second click either breaks in upon what for me is a repetition of the first member ('shorter' judgments), coincides with the end of that repetition ('equal' judgments), or comes after the repetition is over ('longer' judgments)."

W relies somewhat on visual imagery, and more on kinaesthesia.

"Before I gave the judgment, I recalled the tone and clicks in succession auditorily and visually, and respiratorily, as though I were actually producing the tone." W does not speak definitely of "laying-off the first on the second," but he apparently does this, because he almost always reports "it is as if you expected the second click to come about the time of the end of the first sound"; "expected the second click at about the duration of the first tone, and it came earlier."

Beside these common judgments by secondary images called up after the end of the second member, or some image or representation of the first member laid along the second while in course, we find various other methods of judging. "Automatic" or "unconscious" judgments are reported at times, as they were in the first group of experiments.

Bi says: "Notice this morning a tendency for consciousness to drop out, much like the action consciousness passing from impulse to reflex"; "the click interval merely seemed longer"; "the judgment came as if from the unconscious."

D reports: "Don't think there was much of anything between the last member and ringing the bell"; "perfectly spontaneous. Just pressed the button without thinking anything consciously."

F; "second click just didn't come when I knew it should. Didn't go over the experience in image. Judgment automatic"; "after second click automatically pressed the button"; "judgment just seemed to be a sort of motor judgment."

F gives two further methods by which he can judge the members, one in which he "lets the judgments take care of themselves," and another in which he takes the two members in a rhythm. "I sit back much more passively. I let the tone impress me as so-and-so long. Instead of apprehending it as a thing getting progressively longer (as I ordinarily do), I apprehend it as a unitary duration. I apprehend the second member as a unitary duration. I do not make a comparison of the two durations explicitly, but allow the judgment to take care of itself. The preparation of the fore-period and the habit of reacting seem to do all the work for me, seem to touch off the judgment reaction. Have a feeling that I am physically more accurate if I judge by the other method." This method, however, he forsook as unsatisfactory, and later tried another. "I prepared myself to perceive the whole thing in a rhythm." Such a procedure proved to be practically the equivalent of "expecting the second member to stop at a certain definite point."

W reports several times that he gave a vocal-motor judgment of the absolute length of the first member.

Three observers report a change in attitude toward the experiment as the group progressed.

Bo "took signal bell and first member passively, as a matter of course"; "maintained a careless attitude throughout." Soon after the development of this passive attitude, however, Bo adopted the method of kinaesthetic laying-off of the first member on the second; and with the adoption of the new method, his remarks on passivity cease.

F; "I believe that to-day I am taking the whole experience more passively"; "none of the experience is as clear as it used to be when I was actively attentive."

W; "general feeling of familiarity about the situation, sitting back, relaxed, less strain"; "am taking the whole thing more passively. The sound went on and, my attitude being passive, I let it go on without any effort to estimate its length or anything of the sort. Have a sort of feeling that the whole thing is becoming more mechanical,

somehow as though I were willing to give judgments without much pains."

Unless observers are questioned in regard to the interval between the members, they tend to omit all mention of it.

When Bi does speak of the interval, he usually reports it as "a blank," though occasionally he says "throat kinaesthesia repeating the tone"; "noticed that I inspired in the interval."

Bo reports occasional images and representations of the first member at this time.

D hardly ever mentions the interval, and when questioned says he has forgotten all about it.

F says: "the interval is just the same as if it weren't there," although occasionally he reports: "expectantly set myself for the first click."

W; "it's funny how little knowledge one has retrospectively of the interval; you know there is a gap there, but as to the real length of the gap you haven't much idea."

At times the observers also reported on comparisons which they were not instructed to report upon, as, for example, the comparative lengths of the first members of succeeding pairs of stimuli.

Bo: "There is a tendency always to judge not only between the tone and clicks presented in any pair, but also between them and those in the preceding pair. This time the tone was shorter than the preceding tone, and the clicks longer than the previous clicks. These judgments force themselves into consciousness along with the judgment I'm supposed to make. They come perfectly spontaneously."

D: "There seemed to be quite a difference between this first member and the first members of the non-introspective series to-day."

W: "There seems to be a sort of comparison of the length of the first member with the 'average length of the first members.'"

As was the case with Group I, we find in this group a number of statements concerning the durational aspect of the experiences.

Bi: "there is not much to be said about the tone. It merely seemed to exist for a certain time."

Bo: "I doubt very much whether one ever recalls duration as duration. In recalling an interval a great part of the durativeness is the accompanying kinaesthetic course."

D: "The tone seems to be a continuous thing; when you get to the end, you still have the first part. The second member (empty), however, seems disjointed"; "when I leave the muscular feel out of consideration or try to prevent it, the second member becomes just two disconnected sounds without relation to each other or to the rest. The first member is a compact whole and has in itself duration, i. e., a continued stimulation, so that I hear the sound right along, the beginning seems to carry over and stay in consciousness until the end comes; whereas the second member seems like two disjointed points and the interval between them has no quality of duration in itself except as I put it in by means of organic and muscular sensations. The only temporal thing about the second member seems to be that the two sounds are not together."

F: "In spite of its qualitative and intensive changes, the first member appeals to me as one tone lasting a certain time. Its duration is, or has something to do *with*, or is impressed on me *by*, these changes;" with the passive attitude, "the qualitative aspect of the tone doesn't impress me. All I can say is, the tone impresses me as a duration;" "the first member is apprehended as a single thing *going forward*. I don't know what going forward means save this, that the beginning

of the tone is in some sense still in consciousness when the last of it comes. In spite of its being successive, the tone is in a sense simultaneous."

W: "Am wondering whether both members are not altogether in consciousness, i. e., in the conscious present."

Summary of introspections on Group 2: With new conditions, secondary criteria are again prominent at first. Although these tend to become less prominent or to drop out, the tendency is, on the whole, less marked than it was in Group 1. It would seem probable, with the increase in practice, that the mechanising of the judgment which was so clearly marked with some observers in the first group, would here become still more prominent. On the contrary, many secondary criteria are reported near the end of the group. The continued use of secondary criteria may, then, be due to the difference in the stimuli in the two groups. The difference in the case of judgment of these groups comes out more significantly in the remarks made in connection with Group 6 and will be discussed in detail later. Moreover, in this group we find distinctions drawn (especially by F) between various attitudes which may be adopted toward the experiment. The "passive" attitude which he takes at times led later to a change of instructions to the observers (see Group 6). The "taking the whole thing as a rhythm" which he reports seems really to amount to an expectation of the end of the second member at a certain time, and under the latter terminology will be found in much of the later work of all observers. The fact that, unless the observers were instructed particularly to report on the interval between the members, they usually neglected to mention it or spoke of it as a blank, brings out rather clearly the fact that an observer is likely to report what he is set for (either by the experimenter or by himself), and that one reason why so many secondary criteria appear in the introspections may be due to the fact that the observers were instructed to "be on the look-out for secondary criteria." Further reference will be made to this influence of *Aufgabe* on the report under the experiments (Groups 6 ff.) which were made under other instructions. Finally we continue to find introspective evidence as to the ultimate nature of duration and its two 'dimensions.'

Group 3

This group of experiments is like Group 2 in having both quantitative and introspective series, in using both filled and empty times, in the standard times used ($60^\circ = 1.2$ sec.; $90^\circ = 1.8$ sec.), and in the instructions given to the observ-

ers. It differs from the second group in having the empty time given before the filled, and in having each day the introspective taken before the quantitative series.

TABLE 2

Auditory stimuli. Empty—filled. Introspective series before the quantitative. Filled time the standard. Five cases each.

	S = 60°				S = 90°			
	Dl ₁	h	Dl _u	h	Dl ₁	h	Dl _u	h
Bi.....	18.3	.012	27.7	.022	-8.8	.016	29.5	.021
Bo.....	13.4	.054	-1.1	.018	10.0	.032	3.0	.023
D.....	17.3	.077	6.4	.028	33.2	.057	18.2	.028
F.....	-5.0	.044	9.7	.033	-10.1	.460	28.2	.022
W.....	16.1	.055	-19.4	.018	30.0	.011	-1.4	.015

The most noticeable thing about the quantitative results is the *great variation in the limens*. F shows the same tendency that he showed in Group 2, to overestimate the empty interval; W and Bo, on the contrary, tend rather to overestimate the filled interval. The introspections may throw some light on the variations.

Introspective results: The introspective reports for this group give comparatively little that has not been at least hinted in the preceding groups.

Bi still clings to visual images, giving the temporal relations of the members as spatial relations. These representations usually arise during the course of the members, and are held together for comparison.

Bo continues to parallel the second member with an "organic pattern (respiratory and neck-kinaesthesia)". In the interval between the members Bo often reports images of the clicks, and distinguishes between images of the continuous tone and those of the empty interval. The latter differ from the former; "a reproduction of the first member, I think entirely auditory. It baffles me completely to say just how it is that I get those two clicks after one another. There doesn't seem to be any lapse of time in their succession. I think I mean, however, by lapse of time, the organic accompaniments. In other words, the successive separateness of the imagined clicks is so unlike duration, as I generally mean duration by means of organic processes, that it scarcely seems as if it should be reported as such;" "the clicks came up in auditory imagery, visually supplemented, and as separated without a definite durational displacement."

D has difficulty, not only in imaging the clicks at their proper distance apart, but also with the first member while it is going on. "The time between the clicks as far as I can see now is practically empty

and, as I remember, there is nothing temporal about it, i. e., I have no definite idea of how far apart the clicks were in time except the general notion that they weren't very near together, because by the time the second came, I had completely lost the first;" "the judgment is not spontaneous. It isn't self-evident which one of the members is longer and I usually arrive at my judgment by a process of elimination. I usually remember fairly well what the length of the second member is, and make a guess at the first. I can usually tell when the first member is very short or very long, but, of course, these don't happen very often. When it is in the middle ground, I think to some extent I neglect the particular member, and compare the second with what would be a 'medium length' member." Later, D voluntarily sets up a course of organic and muscular feels along with the first member, in order to have something to carry over to compare with the second. "I am compelling myself to carry the first over (organic and muscular) to compare with the second."

F continues one of his old methods, that of apprehending the second member as a repetition of the first. "The second member is perceived in the sense of a repetition of the first. I am uncertain whether I hear two clicks, image two clicks, or whether I merely *mean* two clicks in the case of the second member. I incline toward the second possibility. I do hear the tone;" "the judgment is quite an automatic thing. Half a second after I have pushed the button I couldn't tell how many times I pushed it. I certainly push it before I even have time to go over the thing in imagery."

W at first relies to a great extent on secondary criteria of several kinds, but reports with more and more frequency as the experiments continue many judgments of absolute length; "some slight strain before the second click made the first member seem absolutely long, without seeming to compare it with anything"; "after the clicks came I said 'short'"; "when the tone was ended I said 'short,' and rang the judgment 'shorter.'" W also reports occasionally as follows: "One is strongly tempted in this case to say that one interval is longer than the other and that's all there is to it. They're so short that the usual criteria are apparently, as far as I can discover, not present. The visualisation is fully as immediate a thing as one can imagine. There is no effort to visualise, it is simply there. The interval between the clicks is so long or so short, simply *there*, and the line representing the tone is so long or so short, simply *there* again, and in this case, at least, there is no attempt to measure one beside the other, the judgment is immediate; you *know* that one is longer, that is all I can say."

Some observers give evidence that the length of the members varies with the manner in which it is represented.

Bi: "as I think of the clicks now in visual terms the distance between them is very great, but in some other terms it was considerably less. I can't tell what these other terms are. They seemed to be a vague bodily kinaesthesia localised more in the head and eyes than anywhere else. The difference between these two values of click interval may possibly be the difference between the interval taken as filled time and the interval taken as empty time. The click interval seems to have empty time value while it is going on, but when the tone comes, the click interval seems to be filled up with a tone;" "this time the long value for the click interval didn't make its appearance"; "could judge the click interval either as immensely long or as awfully short"; "some trouble with the judgment because the clicks were in kinaesthesia, and the tone in vision."

Bo reports: "The members kinaesthetically together, but immediately afterward I got a visual image of the first member ending first"; "second member and represented first member ended coterminally. Immediate visual image in which the second member was seen as shorter than the first member, and a sort of organic tag to the visual imagery, seemed to verify this decision."

Summary of introspections for Group 3: The chief points here are that it seems much more difficult to "carry over" a first member when it is empty than when it is filled, and that all kinds of evaluations of the empty interval seem less certain and less spontaneous than evaluations of the filled interval. An important point for the explanation of the quantitative results is that the empty interval seems to vary in length according to the way it is represented. It is impossible from these results to say which representations seem to be the shorter. Another possible explanation for the irregularity of the quantitative results lay in a suggestion made by F at the end of the group. This observer had objected more or less all through the group to the plan of having the introspective series each day before the quantitative series, as he got into the introspective mood and it was difficult or impossible to get back to a quantitative set. It seemed that the position of the introspective series might have affected the different observers in different ways, and Group 4 of the experiments was made to test this point.

Group 4

This group consists of quantitative experiments similar to those of Group 3, except that no introspective series were given at the beginning of the hour. Some of the observers had noted during the last group that certain of their 'equal' judgments were judgments of equality,³⁷ while others were simply 'doubtful' judgments. In this group all observers were requested to report judgments of true equality through the speaking tube, while the merely 'doubtful' judgments were rung in as all 'equal' ones had been formerly. In the construction of the quantitative table given below, all "equal" judgments are considered together. In this group the experimenter timed the interval between the end of the second member and the ringing of the judgment,³⁸ although the observers did not know this was being done.

³⁷ Bo reports: "The judgment 'equal' really meant uncertainty as to 'longer' or 'shorter,' a frequent meaning of 'equal' for me."

³⁸ By starting a stop watch when the last contact was moved and stopping it when the first ring came.

TABLE 3

Auditory stimuli. Empty—filled. Filled the standard. Ten cases each. No introspective series. Distinctions drawn between "positive" equality and "equal doubtful" judgments.

	S = 60°				S = 90°			
	Dl _i	h	Dl _u	h	Dl _i	h	Dl _u	h
Bi.....	9.3	.073	17.6	.031	7.0	.025	27.8	.187
Bo.....	22.8	.036	-1.9	.042	21.8	.025	20.3	.032
D.....	24.1	.092	-4.6	.070	37.2	.023	— .6	.025
F.....	-1.1	.054	17.8	.040	-5.4	.023	33.6	.030
W.....	26.1	.093	-20.0	.043	16.8	.025	4.1	.046

If we compare this table with Table 2, we find no apparent reason for supposing that the position of the introspective series was significant in the quantitative results. On the contrary, Table 3 shows for over half the observers a wider range between the two limens (this may be due to an increased emphasis on the possibility of "equal" judgments given by the changed instructions in regard to the equal judgments); shows no marked increase in the size of the *h*; shows negative limens for the same observers (except the one slight change from negative to positive in the case of W); and even shows two new negative limens in the case of D. We must conclude, therefore, that the wide individual variations in Table 2 are not the direct result of the position of the introspective series, but are probably referable to some peculiarity of carrying over an "empty" time to be compared with a filled. It will be remembered that the different observers used a variety of methods, differing from observer to observer and for one observer from day to day; and it seems natural that such a range of possible representations of the first member should result in widely divergent results.³⁹

³⁹ Katz (*op. cit.*, 312, 324, etc.) insists that it is possible to compare the results of different observers only when we have found the interval most advantageous for each, and when we require every observer to behave in the same way in the interval between the members; one should not be allowed to call up the first member in imagery while another does not, and so on.

TABLE 4

A comparison of "equal" judgments, divided into "positively equal" and "equal doubtful," made in Group 3 of the experiments.

Total number of	S = 60°					S = 90°				
	Bi	Bo	D	F	W	Bi	Bo	D	F	W
"Positively equal"	22	21	36	26	0	13	45	45	25	0
"Equal doubtful"	33	21	4	21	32	36	28	16	27	60

From this table it appears that the greater number of D's equality judgments are judgments of "positive equality," whereas all W's judgments are judgments of "equal doubtful." Upon reference to the introspective records, a parallel distinction between these two observers is found; D persistently relies on his muscular and organic representation of the first member as compared with the second while the second is in progress. In other groups (p. 15) he says that if this "'feel' is left unchanged by the second member, the second is judged equal to the first; if it is changed by the 'feel' of the second member, the judgment is 'longer' or 'shorter'." With such a method, the judgment would tend to be that the second was positively equal to the first, rather than doubt whether it were longer or shorter. W, on the contrary, relies to great extent on judgment of the absolute impression of the members, and so is set to get the second as "long" or "short"; and in the cases where they are near together, would naturally ring a judgment that meant he could not decide whether the second were "long" or "short." The other three observers seem to lie between the extremes of D and W in their methods of judging and would, therefore, be expected to lie between them in the kinds of equal judgments passed.

TABLE 5

Average time in seconds between the end of the second member and the beginning of the ringing of the judgment, in experiments of Group 4.

Judgments	S = 60°					S = 90°				
	<	=	>	< or =	= or >	<	=	>	< or =	= or >
Bi.....	1.2	1.8	1.1			1.1	1.4	1.3		
Bo.....	2.2	2.7	1.5	4.9	5.1	2.0	2.5	1.7	5.9	3.3
D.....	1.6	2.1	1.3			1.4	1.9	1.3		
F.....	1.2	2.0	1.3	2.8	2.9	1.2	1.6	1.4	2.2	3.2
W.....	1.8	2.9	1.1	4.5	3.5	1.4	2.5	1.2	3.0	3.2

The first conclusion from the table is that the judgments arranged in order, from that taking the longest to that taking the shortest reaction-time, stand as follows: less(?); greater(?); equal; less; greater. This is, of course, natural enough, and agrees with the introspections, which often report, when the second member is much longer than the first, that the judgment was ready as soon as the second member reached the place at which it would have stopped if it had equaled the first member; in such cases the observers often reported that they waited for the second member to finish sounding before ringing the judgment.⁴⁰

Group 5

This group consisted of a few merely introspective series, introduced to see what the effect would be if the observer did not "carry the first over" to compare it with the second. The simplest method of assuring the desired condition was the use of simultaneous instead of successive tones. Two Stern variators set approximately for 400 and 900 v. d. and so chosen that they did not beat or make an unpleasant discord were placed at either side of the observer. The observer was told that he would hear these tones together, and that he was to judge which of the two ended last, and to give an introspection on his experience.

⁴⁰ Katz, *op. cit.*, 447, says that the "judgment greater is always more sure than the judgment less." This agrees more or less with statements of our observers; "was certain of the judgment, though that certainty may have been merely that I reacted very quickly," etc. We should therefore expect the more certain judgments to show the shorter reaction times.

The introspective results proved to add nothing to our data, but they are quoted here for the sake of completeness.

Bi: "Judgment depends upon the fact that the sensation in the left ear lasted longer than the one in the right ear. With the judgment I nodded my head toward the left."

Bo: "Left stopped (I suppose a visual image meant the stop); and at once very smoothly, as if it was already habituated, attention (i. e., ear and eye-kinaesthesia) went to the right."

D: "the decision which is longer depends on first, the localization, whether it is sensation in the right or left ear that becomes attended to; second, on the pitch, for I know the lower pitch and bigger volume is on the left."

F: "judgment automatic, just a nod of my head in that direction"; "attention caught by the high tone sounding alone, and on that basis I judged automatically by a shift of my head."

W: "Tone to my left suddenly became clearer, involuntary movement in that direction"; "distinct sort of thing, that something was going on in the left ear when there wasn't anything in the right."

We had now completed sets of experiments with two filled, filled and empty, and empty and filled intervals. We had found many varieties of criteria for the judgment, particularly where we used both filled and empty times. The filled times were reported as "more durative" than the empty, and as it was the durativeness in which we were particularly interested, it seemed useless to complete the set of experiments by adding a group in which two empty times were compared.

It will be remembered that F reported occasionally "taking the members passively" (p. 16). Meumann had demanded a "passive" attitude with his observers; and Katz ⁴¹ replies "I can only say that when I attempted the behavior proposed by Meumann, this behavior not only caused a great deal of difficulty and a feeling of greater uncertainty with the judgment, but the judgment was not so accurate as with the behavior formerly followed," i. e., when every observer followed the procedure which he deemed to procure the best results. Katz says, moreover, that "with Meumann's proposed passive behavior, the judgment is very uncertain. The sounds really come to consciousness isolated. The experience lacks the continuity of temporal course procured by strain sensations." ⁴² It therefore seemed advisable to carry on at least a few experiments with "passive" instructions.

⁴¹ *Op. cit.*, 337.

⁴² *Op. cit.*, 416.

Group 6

This group consisted of introspective series in which the three previous orders of filled-filled, filled-empty, and empty-filled times were used and in which the instructions were: "As far as you can, give yourself up passively; let the members impress you passively; do not in any way 'lay off' the first on the second member." In this group only one standard, that of 60° (1.2 sec.), was used. Observer D did not serve in this group.

Introspective results: At first Bo reports the uncertainty of judgment and the isolation of the members that Katz had mentioned.

(Empty—filled) 'Determined to be passive, attention on clicks, and body-kinaesthesia and ear-kinaesthesia of attention. No reference to final judgment. Interval between members very confused, no reproduction of the first member, no specific anticipation of the second member, general anticipation involved in reference to instruction, etc. Then gave myself up to the second member. Giving-up is a sort of bodily kinaesthetic slump *plus* heightened ear-kinaesthesia which means attention *plus* the auditory processes. No explicit reference to the first member during the second, although I suppose a certain kinaesthetic uneasiness and eye-movement referred either to the first member or to the coming judgment. After the second member came a blank which was body-organics, a self-consciousness. Then I felt confused because no judgment came and I tried to get one immediately (mostly kinaesthesia). Then I reinstated the members, first one and then the other, in visual, auditory and kinaesthetic imagery. No judgment at first, the two just did not seem comparable, not greater, nor equal, nor less. Finally I got the two together visually, a concurrence which does seem to be possible in auditory-kinaesthetic reproduction. The two that stood together were the same length, but I did not have any great certainty that this visual image really represented the original.' "No judgment at all after the second member. I knew that both members were rather short absolutely. Completely baffled, however, as to the judgment." "Gave myself up to the first member. After the end of it, the member was repeated in similar terms (audition and ear-kinaesthesia). The second member was clear in auditory processes, very detailed visual processes, and the kinaesthesia of auditory attention. After the second member there was no judgment at all." It will be remembered that Bo had always taken the members "very actively." He was accustomed to run the first member in organic and kinaesthetic imagery along with the second member; and, evidently, the instructions to dispense altogether with this procedure had the effect of setting him not to judge. The possibility of judging the members by any other means than by voluntarily aroused images of the two after the stimuli had ceased or by running a reproduction of the first along with the second had not occurred to him before, and so the new instructions baffled him. It is likely that in a similar way Katz' observers who were accustomed to judging by strain sensations were likewise baffled. Bo, however, in the later part of this group of experiments to a great degree stopped reporting uncertainty. He reports: (filled—empty) "The first mem-

ber was clear throughout in the typically passive way. I think this typical passivity is that the tone was clear auditorily but all the kinaesthesia was irrelevant. The judgment came by way of an indefinite visual image and hand-kinaesthesia. I am not sure the visual image was essential. The feel of my hand wanting to press the button came just as soon and might have proved an adequate cue. I am rather set under this *Aufgabe* to make the judgment on any cue at all, I am so afraid of not being able to judge at all." As the experiments progressed, Bo reports judgments made on the basis of imagery arising at the end of the second member and apparently not sufficient to carry the meaning which it does seem to carry: (filled—empty) "After the second member there was a blank, almost meaningless kinaesthetic pause, a waiting. Then all at once there was an experience which *meant* 'equal.' It wasn't verbal, it wasn't numerical, i. e., it required subsequent processes for the idea of two rings to come up; it *did* mean a definite decision, and it *was*, as far as I can tell, nothing but a thing like a kinaesthetic twitch inside my head and perhaps an eye-kinaesthesia *plus* a vague background of visual imagery. How on earth such a thing gets to mean decision, not to say equality, is more than I can say." Still later, Bo gets still further away from the baffled uncertainty that the passive attitude brought at first. (Empty—filled) "Very meagre consciousness. The experience is like that of the mechanical judgment which runs itself off without consideration." "Judgment seems to be getting automatic and to have less to do with consciousness. Feeling of certainty as to the judgment without, however, anything conscious like comparison. I cannot explain the formation of the judgment. There was no reference to the first member after it lapsed, very little to the second, no comparison or effort to compare, no simultaneous visualisation or imagining." "I am not aware that I anticipated that the ring would be 'one.' I knew it was one as soon as I had rung." (Filled—filled) "At the end of the second member there came in with no effort, I think no pause, easily, passively, the idea of 'longer.' I noted that the idea was very thin and simple, that it had no obviously explicit reference to the tones, and I wonder now if it was anything more than a feeling of certainty. Think the ringing was quite mechanical." "I think of it as a reaction, not as a judgment." We have here, then, in the case of Bo an apparent dropping out of consciousness with the passive instructions. It seems probable on this evidence that if Katz' observers had been compelled to continue the passive attitude long enough, they too would have lost the uncertainty, etc. The loss of uncertainty as to the judgment may mean that with the passive attitude there is less stress on the observer to judge as accurately as he can; but this point can be settled only by quantitative series. (See Group 7.) The question of the significance of the passive attitude for our problem will be discussed at the end of the experiments performed under this instruction. (Filled—filled) "I can judge better if I don't attend too well to the tones."

Unlike Bo, the other observers did not report themselves as ever "completely baffled," although they show in Group 7 (given under similar instructions) that the adoption of the passive attitude is confusing and often results in no judgment (see pp. 29ff).

Like Bo, all report judgments without conscious comparison. Bi (empty—filled) "heard the first click, and then later heard the second one. I may have had a slight idea of the amount of time between them, but it was certainly less definite than in other experiments. The

course of the tone was quite indistinct too. I heard it, but didn't mark off the ends of it at all distinctly. The judgment came spontaneously, as nearly as I can tell, touched off by the realisation that both members had been given; i. e., just as soon as I realised that both members had been given, I seemed to have my judgment ready. Except for the fact of equality there was nothing else conscious except the vaguest sort of kinaesthesia." (Filled-filled) "I think so far as consciousness goes, passive means unattentive"; (filled-empty) "at the end I began to wonder what the judgment was, and what I must ring, and when I came to ringing, I found I had already done that."

F says: (filled-empty) "Can't be analytic and at the same time passive, somehow. All I know is that the first member seemed longer than the second." (Empty-filled) "Obeyed instructions as far as I know, and the judgment went perfectly easily, didn't lay one off on the other"; "second member did seem longer. My thumb presses the button, that's all I know." (Filled-empty) "First member struck me as being absolutely long. The second member was perceived as a rhythm. Automatic judgment. Thumb just pressed the button." (Filled-filled) "Can't find a single thing in the way of mental process or in the way of changed intensity, changed general quality, changed strain, or anything of that sort that I can tell represents the knowledge that the second has gone on as far as the first; but I do *know* somehow or other, consciously or unconsciously, *precisely when* that second has gone on as far as the first."

W seemed to have less difficulty than the other observers in adopting the passive attitude. He reports: (filled-empty) "When the clicks came, the judgment was touched off at once. There was no comparison or anything of that sort." (Filled-filled) "The tone seemed very long. So far as I know there was no secondary criterion, and yet the thing seemed to last interminably. So far as I know, there was no basis for the judgment except that the first tone was long and the second was shorter." (Filled-empty) "Am rather impressed by the tendency for secondary criteria to come in when there is doubt"; (empty-filled) "I have the general *Aufgabe* to take the thing naively, but the determination to report makes it a good deal more difficult to maintain this *Aufgabe*"; (filled-filled) "I have always found that the successful inhibition of secondary criteria didn't interfere one whit with my ability to judge, or with the experience of going-on-ness (or duration, if you like). I've usually found, however, that when one criterion was inhibited another was very apt to take its place, and this I now believe was due to a predisposition to report and to make an accurate report, not only as regards the mental processes, secondary criteria and everything that's there, but also as regards the judgment itself. Under the present *Aufgabe*, the feeling of necessity that I must make a very accurate report as regards the judgment is lacking, and the secondary criteria fall away, so that I seem to be left with nothing but the bare experiences of going-on-ness."

Summary of introspections: Under the passive instructions, attention "tends to be lower" (cf. pp. 31f.), there is less determination to be "analytic" and to report in detail. More discussion of the influence of these instructions will be given in the next section, in the discussion of quantitative series taken under the same instruction.

What Bo means when he says he can "judge better if he

does not attend too well" needs some explanation. Starting from a definition of attention as sensory clearness, he says that, even at the times when the members are clear, he does not generally report himself as paying "good attention" unless he "reacts upon them by associative supplementation." Such attention is evidently "strained" attention or "active" attention. The disagreement among various investigators (Katz, Meumann, Nichols, Kahnt, etc.) is doubtless attributable to a difference in definition of the terms "passive" and "attention."⁴³ If by passive one mean 'not paying strained attention,' then since, as we have seen, our observers tend to discontinue the large strains and body-movements which at first seemed necessary to the judgment, our results may be taken to agree with Meumann; whereas, if by passive is meant something like a state of irresponsible reverie, our results (p 32) may be taken in exactly the opposite way.

Group 7

This group consists of a series of quantitative experiments with a few general introspections at the end. Three orders were used; filled-empty, empty-filled, and filled-filled, and two standard times 60° and 90°. These experiments were given with Meumann's passive instructions.

TABLE 6

Auditory stimuli. Passive attitude. Filled—filled. Second member the standard. Five cases each.

	S = 60°				S = 90°			
	D1 _l	h	D1 _u	h	D1 _l	h	D1 _u	h
Bi.....	10.0°	.020	4.3°	.023	25.9	.037	-11.1°	.035
Bo.....	18.3	.119	18.5	.024	18.8	.042	-25.0	.007
D.....	14.1	.080	-2.4	.036	32.1	.023	1.3	.104
F.....	6.2	.068	2.6	.077	9.1	.080	3.9	.070
W.....	10.2	.072	-4.1	.080	16.2	.037	8.0	.015

⁴³ Katz reports (*op. cit.*, 321), that his observers at first found that slight movements helped the judgment, but that soon these voluntary movements dropped out, because they "*took too much attention*" (*italics mine*). If, then, strained attention really means increased attention to bodily strains and correspondingly decreased attention to the members to be compared, it is small wonder that some writers have taken the best condition for the comparison to be "not too high" attention.

TABLE 7

Auditory stimuli. Filled—empty. Passive attitude. Filled the standard. Five cases each.

	S = 60°				S = 90°			
	D1 ₁	h	D1 ₁	h	D1 ₁	h	D1 _u	h
Bi.....	-33.6	.064	60.4	.026	-20.6	.013	43.6	.059
Bo.....	-18.7	.019	66.5	.013	-23.0	.020	48.8	.026
D.....	3.8	.025	29.1	.022	19.5	.002	45.6	.016
F.....	-27.9	.031	32.4	.038	-22.2	.032	28.4	.050
W.....	-15.1	.035	30.6	.030	-4.1	.022	36.9	.021

TABLE 8

Auditory stimuli. Empty—filled. Passive attitude. Filled the standard. Five cases each.

	S = 60°				S = 90°			
	D1 ₁	h	D1 _u	h	D1 ₁	h	D1 _u	h
Bi.....	15.2°	.024	14.4°	.032	-9.0	.029	25.4°	.028
Bo.....	12.0	.044	22.6	.012	16.5	.012	38.6	.014
D.....	18.1	.050	-9.4	.119	18.6	.022	21.5	.020
F.....	-8.6	.028	20.2	.046	-18.8	.016	41.7	.012
W.....	23.0	.061	5.5	.020	-6.7	.006	35.0	.024

On account of the lack of quantitative results for Group 1, we are unable to compare the results for two filled times under the different instructions. With the filled-empty order, we find much smaller limens under the original instructions than under Meumann's 'passive' instructions, and in general the values for *h* run higher with the "active instructions." The tendency in the case of the empty-filled times is not so marked, although the *h* show a decided tendency to be higher with the active attitude. These results, then, seem to uphold Katz in his statement that judgments under Meumann's instructions are less accurate than those under active instructions; and since the observers report that passivity in general means less attention, they refute those of Meumann, Nichols, and Kahnt in having the results more accurate if attention is

high. However, as has been said (p. 29), these writers are doubtless using the word "attention" to mean "strained" attention.

Introspections on Group 7: Any introspections offered by the observers day by day were recorded, and at the end of the Group the experimenter asked for general introspections over the whole series.

Bi: "Passivity seems to mean that I am to listen to the members, but not to listen hard enough to call up imagery of any sort. Try just barely to hear the tone, to have nothing but the auditory sensation. All repeating of the first member is ruled out in the passive series. There are all degrees of certainty, sometimes the judgment came as automatically as could be. Any click interval is harder to judge than the tone interval. I feel more sure of my judgments with the active attitude, though there are certain ones with the passive attitude when it seems to go off well."

Bo: "Two tones are much easier than clicks and tone." "With two tones the judgments are much more immediate. Sometimes the passive attitude gets away with me and attention is poor. Then I have to compare the members in imagery and subjective certainty is much less. I think subjective certainty is much greater with the active attitude. It certainly is very low with 'clicks and tone,' although with a few stimuli of extreme length subjective certainty is always very high. Attention is certainly better with active attitude, at least on the average. It certainly fluctuates with the passive. You tend not to attend when you are passive."

D: "It is easiest to judge with two tones, is quite easy with these, in fact, and for that reason the matter of passivity has not been at all difficult with these, and I have a feeling that my judgments are far more accurate with both tones than with clicks and tone, i. e., that I can judge smaller differences. It was harder to be passive with the tone and clicks. Subjective certainty was certainly greater with the active instructions, except for the case of both tones, where it didn't seem necessary to be active. The passive attitude has very little muscular strain with it, whereas the active attitude has a rather indefinite muscular tenseness. With the passive, I have lapses of attention."

F: "I can distinguish several different attitudes which you can take toward the thing. If you give yourself up passively, you find yourself lost, no immediate judgment coming. You try to make a judgment, then that involves visualising the two members with eye-kinaesthesia helping out, and in a sense that is laying one off on the other, so you give that up. Then you put the emphasis on 'not laying one off on the other' and tell yourself to take the two members merely as two times. Then two things may happen: You may find that taking the click interval as a time means kinaesthesia and you find that you neglect the tonal aspect of the second member, don't attend to the tone, second member is tone in the background and *kinaesthesia* in the foreground, and that means you're laying off one kinaesthetically on the other; or you do as I have been doing lately, tell yourself you will *follow* both of them, glide along with both of them. Haven't analysed that entirely, but you seem to glide along with the first one so far, and you glide along with the second one so far, always somehow in comparison with the amount you have glided along with the first, so that in this case you have practically made the empty interval

a thing that you follow as you follow the changing, the going-forward tone. . . . You can take the tone as a *time* between its beginning and end, in which case you don't attend to the tone as a tone, or you can follow the tone, and as a matter of fact you can take *both* these attitudes towards a single member, though not at once. The judgment is not immediate and it makes all the difference which of the two attitudes you take. There is a difference between the time between two points and a time that goes on and you follow; the time that is extended and the time that goes on. The natural time between the clicks is the first kind, and the natural and immediate time of the tone is the second. So that you really have to make one time over into the other by an attitude or a determination (like the determination not to take the second member as a tone) to get an immediate judgment." "Real difference between the two members temporally. In the first member the time of the first member somehow doesn't *move*, but rather *intensifies* or grows, as though you watched the time; in the second member, you follow the process, the time moves. . . . The time of the first (clicks) is a dead sort of thing; the time of the second is alive; the time of the first member is much more all-there-at-once than is the time of the second member." F here is apparently making the distinction which Moede⁴⁴ draws between duration and progression. We shall refer to this point later when in the conclusion we discuss the distinction between duration, temporal course, progression, etc.

F gives various other attitudes which he can take toward the comparison, such as taking the members as absolute impressions, etc. Subjective certainty is greater with the active attitude, particularly in the case of filled-empty and empty-filled. "I think secondary criteria are more apt to come in with the active attitude." "Strain sensations are, I think, more prominent with the active attitude, at least, since introspection is easier, they are found more, and the same holds true for images."

W reports: "Subjective certainty greater as a rule with the active, attention better with the active, and secondary criteria tend to come in more with the active. It is much easier to judge two tones than tones and clicks."

Beside the introspective evidence, it is interesting to note that during the course of the experiments Bi reported that he couldn't make one judgment because he was "too passive"; Bo remarked after some series with empty-filled order: "On the scale of 10, subjective certainty with these instructions is about minus 3"; in one case he said he had "no impulse to judge," and twice that he "forgot to judge." D reported twice that he had "no judgment, was too passive" and once that he "didn't make any judgment"; and F said once that he was "too passive" to judge.

Under Meumann's passive instructions, then, strained attention tends to become lower. Subjective certainty and even the determination to judge are less than under active instructions. We find, moreover, that the tendency not to report secondary criteria is so great here that it is sometimes impossible for the observer to say whether strains, weak images, and so on, are present or not. We have here good evidence

⁴⁴ *Op cit.*, 366.

that Meumann's observers, being under passive instructions, could not have found the strains, etc., even if they had been set to look for them; and as they were instructed definitely against getting them, it is no wonder that they did not. Neither is it any wonder that other investigators, working under a different *Aufgabe*, have strains, etc., continually reported. Meumann seems not to have worked with that degree of practice under active instructions in which, although the large bodily movements have disappeared, there still remains a definite kinaesthetic carrying-over of the first member. If he had, he might have found, with us, that accuracy is higher under active than under passive instructions.

Group 8

With the close of the set of experiments under the passive instructions of Meumann, we seemed to come to a natural stopping place. Nothing more was to be hoped from a continuation of work with either of the two instructions (active and passive) that had been used, and no other instructions had been suggested either by the introspections of the observers or in the literature. The stimuli used were, therefore, changed, and the temporal judgment of two continuous lights was investigated.

Apparatus for lights: The apparatus already described, which was used for the control of the length of the auditory members, was again used for the visual stimuli, with the exception that only one contact was used and that this was moved by both pairs of arms as in Group 1.

The arrangement of the stimulus itself was as follows. A ground-glass electric-light bulb was placed in a sound-proof box, behind a lens which projected through the side of the box toward the observer. Black paper was pasted over the lens, in such a way that the spot of light seen by the observer was 3 cm. in diameter. White paper was fastened on the outside of the hole through the box to make the light of a moderate, pleasant intensity, after the observer had become adapted to the darkness of the room. Between the light and the lens was a screen with a hole of the size of the opening of the lens. At either end of the screen were strips of tin at right angles to the cardboard. Two electro-magnets were so placed at the ends of the screen that, when a current was passed through one of them, the tin at that end of the cardboard was held against the magnet and the hole in the cardboard came over the opening of the lens, and the observer saw a circular spot of light; when the current was broken through that magnet and made through the other magnet, the tin on the other end of the screen was held to the second magnet, and the light was cut off. By means of a switch the experimenter could keep the screen held over to shut off the light until the kymograph had attained maximal speed; then, when the switch was turned, the light remained off

except between the times when the first and second, and the third and fourth arms moved the contacts. Tests were made to discover the difference in the time for which the light was visible and the reading on the apparatus, and the error ever exceeded 2° , or .1 sec., with an m.v. of less than 2%. A pin-hole was pricked in the cardboard screen and in the paper which reduced the intensity of the light, so that when the screen shut off the light, there was left a faint glow as a fixation point.⁴⁵

The *instructions* for this group of experiments were worded in a manner slightly different from that used with the auditory stimuli. Up to this time, the use of the word "duration" had been carefully avoided by the experimenter; but as the experiments were drawing to a close, and as, after the temporary introduction of the passive instructions in sequence to the original instructions, the results with the new stimuli would not in any case be truly comparable with the previous results, the instructions were worded to emphasize the term "duration." They were: "You will be shown two lights of the same or of different durations with an interval between. You are to judge whether the second is longer than, shorter than, or equal to the first in duration." Quantitative series were followed each day by introspective series. Only one standard, 60° , was used.

TABLE 9

Visual stimuli. Filled—filled. Ten cases. Second member the standard

	S = 60°			
	D ₁	h	D ₂	h
Bi.....	10.6°	.126	5.0°	.062
Bo.....	43.2	.022	-1.7	.023
D.....	22.4	.034	12.5	.046
F.....	.6	.061	7.4	.031
W.....	16.5	.048	-4.0	.042

The results for Bo are markedly different from those of the other observers, and show apparently a great time-error, for the first member is greatly overestimated (or the second greatly underestimated). The explanations are to be sought in the introspections. A similar but smaller time-error shows

⁴⁵ An attempt was made at first to use the apparatus described by Moede, *op. cit.*, p. 345, but it proved impossible to get a light from a Geissler tube which did not flicker.

in the cases of all but F. Bo and D have the greatest "equality zone," F the least, and Bi and W stand between. Bo's *h* is also small.

Introspective results: We find again gradual dropping-out of consciousness; and we seem to find some effect of the previous passive instructions.

All but one observer note that the light seems to radiate out from the spot. Bi: "The light seems to radiate from the spot during the stimulation." Bo: "The first member got very rapidly brighter until it was dazzling and streaming." D: "The light didn't come instantaneously, but it seemed to open up from around the fixation-point." F: "The first member seems to grow from the center."

As to the mechanism of judgment; Bi: "What I particularly noticed was that about the middle of the second member I found myself taking a new grip on the bell, and actually had to stop to keep myself from ringing before the second member was over. As nearly as I can tell, I didn't realise I had made the judgment, till I found my hand starting to ring. Don't think I was conscious of the first member at all after it had stopped"; "Don't remember much of the first member; nothing but a sort of impression that it had been presented for a certain time and was now over. At a certain point (where the first member would have ended) in the second member, wrist strain appeared. The laying-off was not conscious;" "First member was so very short that it seemed a foregone conclusion that the second would be longer;" "Suddenly when the second member had been going for a short time, from somewhere came a feeling that this member was different from the first, was longer, and all the time after this was really just added on. I didn't intend at a certain time to judge the two members as equal or different, but just found the judgment breaking in on me."

Bo still clings in great part to his kinaesthetic comparisons. "After the second member, no judgment. Then a sort of muscular set to ring 'one,' together with the idea 'the second is always shorter' and the inhibition and subsequent rejection of this tentative judgment. Then a definite visual-kinaesthetic successive comparison. I imaged each and bent over to it, at least in kinaesthetic image. I think the degree of the bend was the duration. Then the idea of equality (visual and muscular) and the judgment;" "was interested most of the time in the apparent shifts of the lights and quite lost sight of my obligation to note duration. At the end of the second, however, I caught myself giving a very decided nod as if I were bending forward in time with the exposure. Then suddenly I became aware I was ringing; think the first thing I knew was the sound of the bell. Very quickly, with some kinaesthetic disturbance, I compared the two visually, i. e., a visual field with two bright figures of different extension, and concluded that the judgment should be less. Don't think the conclusion was anything but a muscular relaxation of the push-button hand after I had rung once." Although Bo gets more automatic in his judgments, he still uses visual and kinaesthetic reference often. "Whole business is quite automatic, and there's not much sense to the conscious side, i. e., meanings are not obvious in the content;" "Judgment followed the second member almost automatically. Immediately after the judgment, I thought that although the two members *felt* the

same length (i. e., kinaesthetic representation), the second had looked shorter." In partial explanation for the difference between Bo's limens and those for the other observers we find at the first "I haven't yet learned to set myself for duration only. The qualitative differences are still most important." All through the series Bo reports many times "after the second member, called them both up in visual (or visual-kinaesthetic) terms"; and it is doubtless the fact that the image of the first member is less accurate than that of the second, and so tends to be represented as longer than it really seemed at the time, combined with Bo's difficulty in getting away from the set to judge quality and intensity, that gives him the marked error in his results.

D at first reports the organic feels which he had in the early experiments: "The visual sensations themselves seem to play little or no part in the judgment. I mean that the visual sensations merely set up this internal set of sensations (breathing and throat) and it is from these that I actually get my notion of the length of time." But later, "The only conscious part of the judgment is the *expression* of the judgment. The judgment itself, while I'm certain of its dependence on these organic complexes, is not made consciously." "The lights have a duration in themselves, but the time, i. e., the different time-values, seems to be more or less in me; I add it on to the sensations by means of little kinaesthetic cues in my throat accompanied by a certain kind of breathing."

F: "The judgment is usually what I should call automatic. As soon as the second member is over, without thinking of what I'm doing, I go ahead and press the button." "I don't think you consciously expect the second light to last as long as the first, i. e., there is nothing conscious that represents that expectation at all; but if that second light, as in this case, simply doesn't stay there as a light as long as the first one did, then there's a reaction of your finger on the bell at once." "What strikes me is how tremendously automatic the whole thing is, even when you are set to introspect. The judgment is so automatic, you don't think about pressing the bell, but just press it, don't say 'greater,' etc., don't think them at all. Don't think about what's going to happen before it happens."

W reports practically nothing but "immediate" judgments. "Second member touched off the vocal-motor judgment 'longer';" "No secondary criteria that I could recognise; an immediate impression of longer; don't like to say it that way because the impression becomes conscious after the judgment is touched off. You just report 'longer,' and that's all." W often reports "I am taking the experiment naively."

In the experiments with auditory stimuli the sounds were reported to change "in quality or in intensity or both" during the course of the member. With visual stimuli, we find nothing of a pulsing as with tones, but we find changes in the quality or intensity of the members. Here again, we find that it is not necessary for an experience to be unchanging in quality and intensity in order to be taken as a single experience "going forward," or as a single experience "with a definite duration," or to be reported as having "its first part there in some sense when the last of it comes."

Bi: "Noticed a spreading out of the rays of light;" "saw a little light and this extended in diameter quite rapidly and then returned to its original size;" "another case of the light swelling up to a certain maximum and then immediately shrinking back again."

Bo: "The first member came in fairly intense, then was suddenly much brighter, and then got darker;" "the member got first light

gray, and then after a moment, bright yellow; " "first member got very much more intense, then decreased in intensity slightly."

D: "The light seems not to be there all of a sudden, but seems to open out from the little spot; " "both the members seemed to come on and go off slowly; " "difficult to describe how the light comes on and goes off. It seems to open out toward me."

F: "The members seem to grow from the center; " "there is a coming on, a spreading of the light, and then it doesn't stay quite the same, in quality I think, mostly; " "the disappearance phase seems to take a shorter time than the appearance phase."

W: "The light got more intensive as it continued; " "slight qualitative or intensive differences in the first light, it wasn't uniform throughout the exposure."

With this group of experiments, then, we have a decided lessening of the conscious processes. This decrease began with the very first group of experiments (which used two filled times under "active" instructions), was retarded or stopped with the comparison of empty and filled intervals under the first instructions, increased rapidly again under the instructions to be passive, and continues to increase (with the possible exception of Bo) with the use of visual stimuli. This does not mean, however, as it might seem to mean, that the mere "going-on" of the members is sufficient to give a judgment of the relative lengths of the members. On the contrary, many reports are found which indicate that, although there is a going-on to the tone itself, there is no measure of the amount of that going-on until other processes (usually kinaesthesia) are introduced. That the judgment may be made without the consciousness of these processes may mean merely that the nervous system has acquired a set for a certain reaction to a certain stimulus, or that the observer is not set for introspection, or to watch for such processes. The importance of kinaesthesia in the reports of the observers was so evident that it seemed profitable to take a series of experiments in which a sense-organ was stimulated which had no primary kinaesthetic sensations of its own (as the eye has eye-kinaesthesia, etc.), and the following experiments were therefore made.

Group 9

In this group of experiments the stimuli were continuous weak electric shocks (80-83 interruptions of the primary circuit per second) upon the arm. The same apparatus for regulating the length of the members was used as formerly; but a small induction coil connected with one cell was introduced into the circuit in the experimenter's room, while the observer had a large electrode on his neck, and a small electrode (consisting of the end of a screw filed smooth and even

with a strip of wood through which it was screwed, so that the observer could not tell any difference in pressure between the wood and the electrode) fastened on his arm. It was found necessary to spend about ten minutes at the beginning of the hour in preliminary work, to assure a "pins and needles" experience without any muscular contraction. The observer shifted the electrode on his arm till he found a position which gave no muscular contraction, and the experimenter varied the strength of the current until the observer reported "pins and needles."⁴⁶

The instructions to the observers were similar to those in the preceding group. Only one standard (60°) was used.

TABLE 10

Electrical stimuli. Filled—filled. Ten cases. Second member the standard.

	S = 60°			
	Dl _i	h	Dl _u	h
Bi.....	9.8	.056	6.1	.069
Bo.....	16.5	.068	2.1	.043
D.....	23.0	.057	11.9	.052
F.....	10.1	.064	.4	.053
W.....	11.3	.052	.5	.042

This table shows a general agreement among the observers, although D has by far the largest equality-zone. The results show the same time-error that was evident in the work with visual stimuli and that, in fact, has appeared in all the work. It is, however, not safe to attempt any comparison between this table and any of the preceding tables except Table 9, on account of the change of instructions; and even a comparison

⁴⁶ It proved necessary each day to make the current comparatively strong at first, because at the beginning of the hour all observers were unable to feel a current which later was so strong as to be excessively unpleasant. When the observer had once felt the current (the first time it was felt it was usually felt as strong), the experimenter reduced the current to a very small amount and, after the observer had reported "pins and needles," the quantitative series were begun. It was occasionally necessary with observer D to reduce the current again about the middle of the hour; and although this procedure changed the conditions somewhat, it changed them less than if the observer had felt the current as steadily increasing in strength.

of Tables 9 and 10 may be misleading, unless it be remembered that all the observers had had more practice in the experiment when they came to Group 9.

The introspections are very similar to the previous introspections.

Bi: "This was one of the cases where in the second member the judgment occurs at that point which marks all the time before it as equal to the first member. Don't know how this point is located, but it seems that the second member has a double function. It exists in its own right as its own time, but it seems to carry along with it the time of the first member. The first member doesn't appear consciously alongside the second member at all." "I seemed to be conscious of only the second member, yet at a certain point in the second I knew what the judgment ought to be." "Attended carefully to the first member, but when it stopped, it disappeared from consciousness, there was no memory of it. I was thinking about a change in intensity in the second member, when this thought was displaced by hearing the sound of the bell, and the feel of my hand pushing the button. I knew what I rang, i. e., after the ringing was over, and felt satisfied with it." "I am just as conscious that the pricking lasts for a certain time as I am that it is a quality of pain." "Think the other factor beside a visual image this time in making the judgment was the absence in the second member of enough stimulus at the end to make it equal to the first member. This is pretty much a feeling. I have experienced much the same sort of thing when I go to a shelf to pick out a book. I am not particularly conscious that I expect to find the book there and yet I never doubt that it is there. Suddenly, now I put up my hand to take it, I find it isn't there at all. Now I seem to have an expectation set up by the first member, just exactly as my experience has made me know that a book is in a certain place. The stopping of the second member before it is equal to the first leaves me in practically the same kind of state. I think this state involves a catching of the breath, and a certain kinaesthetic set like speaking, only nothing is said."

In the case of Bo visual images and kinaesthesia are still prominent. "Judgment very easy. I was set to get durations only, i. e., didn't notice intensive, or qualitative or extensive changes, if there were any. Visualised both members as they were progressing. In the interval I saw the first member drawn out into a length which meant duration. Don't think either member got drawn out into visual extent which meant duration during its course, but there was something which *made* the two seem to have progression and I suspect that something was eye-movement. During the second there was some sort of reference to the first member, although I can't say just what it was, whether obscure visual imagery, or an eye-strain at the point where the first would have ended if laid along the second. The second was, however, somehow long absolutely and the judgment followed without any hesitation. Besides all this there was some sort of muscular aliveness in my arm which may have merely meant the localization of the stimulus, but which I suspect of referring in some way to duration." "The second member ran along very easily. I anticipated the point at which the first would have ended, and knew as soon as the second had gone beyond what the judgment was. Don't know what this anticipation is; all I can say is that I seem to be getting ready to make the judgment at some point in the second and then that suddenly my whole attitude

changes. I seem to see in imagery a point in the course of the second as a significant point. As soon as the second progresses by this point visually, my kinaesthetic attitude is one of relief and the judgment is made. The push of the button was almost automatic this time." "At the end of the second, slight hesitation, then visual comparison." "Absolutely no conscious reference to the judgment or comparison, or the necessity of getting the durational aspect clear until the end of the second. Then suddenly I'm ready to judge 'equal.' The visual imagery is *there*, but it wasn't as clear as the kinaesthetic attitude of decision, and the pushing of the button itself." "Second member was much like the first except that its end is anticipated. As the second approached the point where it should equal the first, I began to press with my finger. Feel sure I have done this before, too. I think what happens in such times is that the termination of the second touches off the ring automatically." Evidence that the variety of Bo's images really confused him in the judgment is given by one case in which the second member was really nearly twice as long as the first. Bo reports: "At the end of the second I simultaneously rang 'equal' and visualised the members as unequal, I reproduced them somehow in tactual-kinaesthetic terms which *seemed* equal, although the unequal visual images persisted."

D added little to his previous reports. "Each member is accompanied by a total feeling, muscular tenseness, general sensations of breathing, throat sensations. The first one holds over and runs along with the second, just how I'm not sure. The complex isn't identically repeated, but the general attitude that is set up carries over. Then that, of course, is affected by the complex which comes from the second member, and the resultant *means directly*, is the judgment."

F: "The judgments are not just as easy and just as immediate and automatic as they were with tones, perhaps a little less disturbing and easier than they were with lights." "I am certainly sure I don't know whether the strains and relaxations are cues to the judgment or not. Sometimes it seems to me that they are; sometimes it seems to me the course of the sensation is the cue; sometimes that little snaps of my eyes are cues (touch off the judgment); sometimes when I'm not analytic at all, I wouldn't be able to tell whether those things are there or not, or what touches it off. Surely sometimes the course may be identical and yet the judgment be 'longer' or 'shorter.' Sometimes I can't tell whether there are strains there or not, and still have a perfectly definite judgment." "I am convinced that changes in intensity and quality are not what I meant by course. What I mean by course is, I think, usually the increasing duration and the changes in the bodily attitude or feeling or the vague strain." "The members just ran their course separately, and there was an automatic judgment, an automatic pushing of the bell. Certainly there is *never* a recall of the first member in image or anything of that sort. There isn't a visual image of the members while they're there, either." "Just the two members there, one after the other, each in its wave of attention, and me in a duration-comparison attitude."

W: "The judgment is touched off immediately without any reference to imagery and without any effort to compare." "There was no attempt to compare the two, the judgment was given immediately." "The judgment this time was again a judgment of duration rather than of length of visual image, although the length was there. The clear thing was a 'going-on' of the stimulus, and the second didn't 'go on' as long as the first." "General attitude one of unconcern, yet

the judgment was touched off immediately and with certainty." "Judgment again touched off, that's all I can say, but with considerable uncertainty this time, though I can't for the life of me catch anything in consciousness except the deliberation, the wait; i. e., my thumb doesn't report at once. There is no thinking, no comparison, one simply doesn't report at once." "I don't think there was anything there but the duration." "The judgment 'almost equal' was touched off vocally before I rang the bell, and yet the bell rang 'shorter' and I was satisfied with the judgment. Your finger does go ahead and press the button, and then there's very apt to be a question raised after the report has been given as to whether or not it was correct."

The sensations on the arm were reported by all observers as unsteady.

Bi: "The first member was a sort of a line of pricks, as if a sewing-machine needle running very rapidly had been run for a certain short distance along the skin;" "there was a change of intensity in the second member."

Bo: "The experience splits up into parts. I visualise it often as a sand glass and as such it is as if the sand streamed first on one place, then shifted a little, then played on another area, etc., with various intensities of blast."

F: "It feels more or less like a trickle of sensation from the skin down into the tissue;" "have a tendency to express it that the sensation seems a little wavy;" "feels like a trickle of tiny drops going down in."

D: "Sensation seems to spread out in zigzag streaks;" "first member pulsed more than the second;" "member changed in intensity."

W: "It is much as if you were tapping very rapidly on my arm with a sharp pointed bristled brush."

These introspections did not bring out, as we hoped they would, the differentiation between a sense-organ which has its own kinaesthesia running along with its sensation and one that has not. One reason is evidently that the effect of practice in automatising the judgment, till it is scarcely more than a reaction, was more effective than the quality and the kinaesthetic accompaniments of the sensation. The observers seem to be arranged in a straight line as regards the number of mechanical or automatic judgments, ranging from W who gives these judgments almost without exception, through F, Bi, D, to Bo who reports them only a very few times.

Conclusion

In the course of our experiments we have found, in some guise or other, all of the secondary criteria of temporal judgments that have been reported by earlier investigators. We have found, for example, the breathing strains of Münsterberg,⁴⁷ the expectation and surprise of Schumann,⁴⁸ the bodily movements,⁴⁹ vague kinaesthesia,⁵⁰ visual imagery⁵¹ and so on, of the other experimenters. No one of

⁴⁷ Pp. 15, 39, etc.

⁴⁸ Pp. 10, 15, 20, etc.

⁴⁹ Pp. 8, 11, etc.

⁵⁰ Pp. 8ff, 20, etc.

⁵¹ Pp. 9, 15, 19, etc.

these aids to the judgment has been found to be essential; for any one could be replaced by any other, although vague kinaesthesia⁵² is almost always reported, and visual imagery is the aid to which all observers turn when in doubt. We have found, moreover, that there are times when the observers are unable to discover anything in consciousness as the basis of the judgment save the mere going-on of the members.⁵³ Such cases were particularly frequent when Meumann's instructions were given, but they were also found before the observers had received those instructions. The first instance is doubtless an example of automatization of the reaction consciousness. The second may be due to the Aufgabe concerned.⁵⁴ As we have said, the ability to discover secondary processes depends largely on the determination given by the instructions, and Meumann's instructions, which set the observer against a detailed analysis of consciousness, could not be expected to bring out reports of many secondary processes.

From the results concerning the mechanism of the temporal judgment, we may conclude that, at first, all observers voluntarily institute movements of the body (of the trunk, or head, or arm, etc.).⁵⁵ After a small amount of practice, these gross movements disappear;⁵⁶ and then all observers report slight, vague strains, usually localised in the organ stimulated, although sometimes making up a general bodily kinaesthesia.⁵⁷ Visual imagery is used as a reference in most cases of doubt.⁵⁸ Finally, with a large amount of practice, all observers tends toward (and some observers reach) an automatic, immediate judgment with no conscious basis save the bare sensation, itself.⁵⁹

From the results concerning the character of duration, we may conclude that, under proper conditions, that is, when the observers are not under too strong a determination to make a *comparison* of times, we may approximate to a mere "going-on" of sensation which corresponds to the vague extendedness of the visual field of the closed eyes. Instances of this from the introspections of the observers may be requoted: Bi, "There is not much to be said about the tone. It merely seemed to exist for a certain time." "Don't remember much of the first member; nothing but a sort of impression that it had been presented for a certain time and was now over." "Very vague notion

⁵² Pp. 9, etc. ⁵³ Pp. 11, 16, etc. ⁵⁴ Pp. 18, 32, etc. ⁵⁵ Pp. 8, 9, etc.

⁵⁶ Pp. 9, 20, etc. ⁵⁷ Pp. 8, 15, 16, 20, etc. ⁵⁸ Pp. 9, 14f, 20, etc.

⁵⁹ Pp. 11, 16, 28, etc.

that the first member was rather short." Bo under passive instructions gives such reports as "No judgment at first, the two just did not seem comparable, not greater, not equal, nor less," "no judgment at all after the second member. I knew that both members were rather short absolutely. Completely baffled, however, as to the judgment." In spite of this lack of judgment, Bo constantly refers to the tones as "going on," as "having a temporal course." D, "I have no definite idea of how far apart the clicks were in time except the general notion that they weren't very near together." "The lights have a duration in themselves, but the time, i. e., the different time-values, seems to be more or less in me; I add it on to the sensation." F continually speaks of the members "going forward, going on, running a course." Like Bo he reports, "If you give yourself up passively you find yourself lost, no immediate judgment coming." W says, "Under the present *Aufgabe* [passive instructions] the feeling of necessity that I must make a very accurate report as regards the judgment is lacking, and the secondary criteria fall away, so that I seem to be left with nothing but the bare experience of going-on-ness."

We have evidence that the tones can be taken in either one of two ways. The duration may be either "static" or "moving," may be either length or progression. This conclusion agrees in the main with the distinction of Moede already quoted (p. 4) between duration and progression, and that of Meumann (p. 3) between succession and duration. The distinction becomes clearer if we refer to the statements of our observers, themselves. Bi: "When the tone had run its course, I seemed to have some sort of judgment of its length." "This time there seemed to be something passing before my eyes, much as if a fine dark thread were being drawn across the line of vision. The length of time during which this running along of the thread continued was the length of the tone. It seemed as if the tone were translated over into that visual form. I call this a line or thread because it is the best term I can think of. This thread, then, began to run before the field of vision at the beginning of the tone and continued to be brought along the whole time of the tone. The whole experience was about the same as if looking through a hole and watching a train go by. I put it this way to make it clear that the experience was not so that it could be observed *in toto* after it had passed, but had to be taken

just as it came." Bo distinguishes between "temporal course" [progression] and "duration" [length], by which he means "a sort of static, non-spatial extension. It is my notion of . . . the measure within a conscious present. It doesn't move along, although it may get bigger." D: "The tone seems to be a continuous thing; when you get to the end, you still have the first part." F: "The sound is all one thing; even though it has a course the sound is nevertheless in another sense all there at once." "Instead of apprehending the tone as a thing getting progressively longer, today I apprehend it as a unitary duration [length]." "You can take the tone as a *time* between its beginning and end, . . . or you can *follow* the tone, and as a matter of fact, you can take *both* these attitudes towards a single member, though not at once. . . . There is a difference between the time between two points and the time that goes on and you follow; the time that is extended, and the time that goes on." Gou speaks of a "fixing" of the duration of the first member. "There seemed to be a prolonging of the tone; this prolongation does not mean that the duration of the tone is made any longer, but just that I have hold of it, as it were." W: "When the tone was over, there was an effort to hold it." "I think of the member as being unrolled." "The first member seems to stand there in the interval." "These intervals somehow have a sort of unity." "Have a feeling that one *perceives* a duration in the same sense that one perceives a tree. It seems to be a unitary sort of thing."

Our results also point to the conclusion that all sensations have the inherent character of going-on or of progression. In this conclusion we agree with all those psychologists who give duration as an attribute of sensation. From the experimental work we may cite as examples of this position: Mach's earlier theory that all sensations are accompanied by the time sense; Vierordt's statement that the "spatial and temporal dimensions of sensory stimuli come, so to speak, immediately into our consciousness"; Nichols' conclusion that "duration is an attribute of every sensation"; and Meumann's presupposition that "the processes of our consciousness . . . are given constantly at the same time as processes of a temporal nature." From the psychologists whose concept of duration as an attribute of sensation is based less directly upon experimental evidence, we may cite Külpe, although we can not agree to the identification of physical and psychical time, and Titchener.

We come now to the question of the place of duration as an attribute. As we have already said, there are two ways of taking the temporal experience, as progression and as length. These stand at quite different levels, and are the results of quite different attitudes toward the experience. A sensation taken as it comes immediately to one, as it comes under a merely existential determination, progresses. The determination to compare or to estimate, however, tends to result in a taking of the experience as a length. Progression is the more ingrained, the more vital aspect of the experience; without progression, length is impossible. Length is something that may or may not be added on afterward and does not belong to the sensation as such. That is, the sensation has length only in retrospect, has length only after it is over, while it has progression while it is going on. In fact, the going-on is the progression, and by going-on we do not mean continuance in physical time, but the immediate experience of going-on. The length is, so to say, a "fixing," a "making static" of the progression for a simultaneous view. It is a consciousness which involves supposing that the first of the tone is still there in some sense when the last of it comes. Now, to obtain this view, the progression must be referred to something outside itself, it must be given a definite beginning. As progressive alone, the experience seems to have no beginning or end. It is related no more to beginning and to end than the field of the closed eyes is related to definite points, say the furthest we can see to right and left; it is mere going-on, that is all there is to it. Length, on the contrary, is most clearly expressed as temporal *distance* between two points. It is the result of a perceptual, rather than of an attributive attitude. We find, from our introspections, that it is more difficult to harden the progression into length at some times than it is at others. At such times the observers report that the member was so long that the first of it was gone before the last came. That is, it did not "compose a single perception," did not impress them "as unitary," "was not in a single wave" or "single span of attention," "was not contained within a single conscious present." For them, as we have seen, progression goes on within such a time, whereas in general the conscious present, taken as a whole, as a perceptual unitary thing, is itself length.⁶⁰

⁶⁰ When Washburn (*loc.cit.*) maintains that the conscious present has no subjective duration, she is quite evidently thinking of duration not as progression, but as the simultaneous view of the experience which we have called length. That she can deny that *progression*

If, then we take duration in the sense of progression as an attribute (and duration in the sense of length as a percept),⁶¹ there arises the question of the status of this progression attribute as compared with that of other attributes. It evidently does not hold the unique place of quality, but belongs with the quantitative attributes which furnish the basis for answers to the question "How much?" Just as extendedness is the basis for answers to "How far?" and intensiveness for "How much?", so progressiveness is the basis for the answers to "How long?" Of the intensive or quantitative attributes, extent seems most closely related to progression; both are vague extensions, continua, only the one is of space, the other of time. Progression is also more or less similar to the generally admitted attribute of intensity. Indeed, our observers sometimes say "it is like having some more of the same thing added on to it." We take it that you can "add more of the same thing" in three different ways: add to it beside itself, i. e., spatially; add to it after itself, i. e., temporally; add to it at the same place and the same time, i. e., intensively. Of these three, intensity is the only one admitted by all psychologists. Its enviable position is due, not to any superiority which it has over extent and progression, but to the fact that Fechner stated its position flatly, and others agreed to his decision without requiring introspective evidence. If, instead of this introduction, intensity had received the experimental treatment that has been accorded to duration, it too would have gone through the stages of being taken as a relation, and as a result of secondary criteria and mediate judgments, through which duration has passed. But in time we should have found, as we have found for duration taken as progression, an inherent aspect of sensation which we must call an attribute.

takes place within this present seems hardly possible. If succession be taken as equivalent to progression, her statement that the "psychologically primitive time judgment is one of succession, not of duration" seems rather to bear out our own thesis that duration, in the meaning of progression, is an attribute of sensation.

⁶¹ Distinctions like that between length and progression do not seem to us peculiar. Quality, extent, intensity, clearness, can all be taken in a similar way. Bare "thatness" is attributive; "redness" (as distinct from blueness or orangeness) is perceptual and involves a reference to other modes of "thatness" or to points on a scale of qualities. Bare "spread-out-ness" is attributive; size is perceptual. Bare "muchness" is attributive; "so loud" is perceptual. Bare "liveliness" is attributive; "so clear" is perceptual.